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THE PHILIPPINE

Agricultural Review

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THE USE OF GOAT VIRUS IN SIMULTANEOUS INOCULATION AGAINST RINDERPEST (PRELIMINARY REPORT)

By TEODULO TOPACIO, D.V.M.

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It is the consensus of opinion among most investigators that the goat is markedly resistant to natural infection with rinderpest. In his recent review of works on rinderpest in different countries of the world, Hubac [1] states that only in rare instances have true epizootics been observed in these animals. Gerlach and Galambos were among the first to observe that virus obtained from the goat was greatly attenuated. On the other hand, Schein [2] of Indo-China seems to have been the first to undertake an extensive study of the goat virus. He kept his goat virus infective to cattle up to 172 passages from goat to goat. A calf injected with blood from the last passage died of typical rinderpest. However, to maintain such a type of virus uniformly virulent is another problem that requires further critical study and experimentation because other workers have had varying results.

In the light of the above investigations, it was thought possible to obtain by a single passage from cattle to a goat a virus potent enough to infect Philippine cattle and carabaos and yet attenuated to such a degree that it would ultimately reduce the quantity of serum ordinarily required in immunizing such animals by the simultaneous method when using cattle virus. For this purpose, a series of sixteen tests was undertaken from May to February, 1924, covering twenty-nine head of cattle and eight carabaos (buffaloes).

Preparation of goat virus.—In all the tests 10 cubic centimeters of citrated virulent cattle blood was injected subcutaneously into a goat, which meant that more than 16 goats were employed. At the apex of fever, the goat was bled from the jugular into a sterile bottle containing potassium citrate

[1] 1926 Hubac, André. Le Traitment et la Prophylaxie de la Peste Bovine, p. 16.

[2] 1924 Ngo-Dinh-Bich and Nguyen-DangLam. Bulletin Veterinaire de L'Indo Chine. July–December, 1924, p. 134.

solution to make a 0.3-per cent solution with the amount of blood drawn. The virulent blood was either used immediately or kept in refrigerator until needed. This was always used *in toto,* but in cases where less than 5 cubic centimeters was administered, 1 or 2 cubic centimeters of physiological salt solution was added to increase the volume. The virulent blood utilized for infecting the virus goat was obtained from native Fuga cattle at the height of rinderpest infection. Rinderpest is uniformly fatal to these cattle, hence they were selected for use throughout the tests. The carabaos employed were of the same origin.

Three Cambodge goats which came from Indo-China were kindly furnished by Dr. V. Buencamino, while one was obtained in Pandacan, Manila. The others were purchased from Los Baños, Laguna Province. Without exception all the goats reacted to the subcutaneous inoculation of 10 cubic centimeters virulent cattle blood and the mortality in both types was 30 per cent.

Rinderpest symptoms in goats.—Goats suffering a severe attack of rinderpest present clinical symptoms similar to those observed in cattle except that usually no ulcerations in the mouth and throat occur. In the course of these tests, only in one animal were slight mouth ulcerations noted. Neither were there any eruptions observed on the skin of the animals. These observations agree with those reported by Ngo-Dinh-Bich and Nguyen-Dang-Lam [3] of Cambodge, Indo-China. On the other hand, in the less severe infection, except for the rather high temperatures, the clinical symptoms usually pass unnoticed.

Serum used.—In every test, fresh cattle or carabao reactor serum made in the Veterinary Research Laboratory was used, except on one animal in test No. 4 and one in test No. 6 where Nhatrang (Institute Pasteur) serum was employed for the purpose of comparison. In test No. 11, non-reactor serum was used. The serum and V. B. were administered subcutaneously throughout the work.

Test No. 1.—May 11, 1923, Fuga bull No. 5081 was inoculated with 25 cubic centimeters of V. B.[4] from goat No. 1 (Pnom-Pehn) freshly drawn. This bull developed typical rinderpest symptoms and died May 20th with characteristic lesions of the

[3] 1917 Schein, H. Annales de L'Institute Pasteur, Vol. 31, 1917, No. 11.
[4] V. B. Abbreviation used in this paper for virulent blood.

disease. The object was to prove that the virus from a single passage through a goat was virulent for cattle.

Test No. 2.—May 28, 1923, Fuga bull No. 5083 received subcutaneously 60 cubic centimeters serum and 5 cubic centimeters fresh V. B. from goat No. 2 (Pnom-Pehn). This bull passed through six days' fever from 39° to 40° C. and recovered without difficulty.

Test No. 3.—July 17, 1923, Fuga bulls No. 5108 and 5106 each received 60 cubic centimeters serum and 5 cubic centimeters V. B. goat (Pandacan) 17 hours old. No reaction resulted. Three days after, bull No. 5106 died of acute tympanitis. July 28th, bull No. 5108 received 25 cubic centimeters fresh V. B. from cattle No. 5735 without reaction, showing that the animal was immune. One year later, another injection of 25 cubic centimeters V. B. cattle No. 5939 was given, and still no reaction followed.

Test No. 4.—August 1, 1923, Fuga cows No. 5133 and 5139 each were given 60 cubic centimeters serum and 5 cubic centimeters fresh V. B. goat No. 6 (Los Baños). Bull No. 5156 received 5 cubic centimeters of same goat virus as control. Cows Nos. 5133 and 5139 had a severe reaction. Cow No. 5139 recovered while No. 5133 aborted, and died three days after. The control bull developed typical rinderpest and was bled to death for virulent blood.

Bull No. 5150 received 60 cubic centimeters Nhatrang serum and 5 cubic centimeters of the same virulent goat blood. The animal had fever, inappetence and diarrhea, but recovered.

Test No. 5.—August 22, 1923, Fuga cows No. 5223 and 5224 each received 60 cubic centimeters carabao serum and 5 cubic centimeters V. B. goat No. 925 (Los Baños) 40 hours old. Fuga bull No. 5225 was given 5 cubic centimeters of same V. B. for control. The two cows showed no reaction while the control bull developed a severe attack and was bled to death for virulent blood. September 3, 1923, the two cows were given 25 cubic centimeters each of fresh cattle V. B. No. 5195 and both remained well, showing that immunity was conferred on the first inoculation.

Test No. 6.—September 6, 1923, Fuga bull No. 5182 received 60 cubic centimeters Nahtrang serum and cow No. 5218 was given 60 cubic centimeters cattle serum, at the same time both received 5 cubic centimeters V. B. goat No. 924 (Los Baños) 24 hours

old. Bull No. 5182 had a strong reaction, inappetence and diarrhea but recovered. Cow 5218 passed through five days' high temperature and recovered.

Test No. 7.—September 9, 1923, Fuga bull No. 2 was given subcutaneously 5 cubic centimeters V. B. goat No. 6, kept in the refrigerator eight days. The bull died of rinderpest September 20, 1923. This showed that goat V. B. obtained by single passage from a bull to a goat was virulent for cattle even when kept in a refrigerator for eight days. Results of above tests decided us to discontinue the use of susceptible cattle as control, since the test animals being used were known to be highly susceptible to rinderpest. Furthermore, all the goats employed in these tests as virus producers proved to be uniformly susceptible to inoculation with the cattle virus .

Test No. 8.—September 12, 1923, Fuga cow No. 5166 and cow No. 5167 each received 60 cubic centimeters of local carabao serum and 2 cubic centimeters V. B. goat No. 923 (Los Baños) freshly drawn. Both animals were in their last month of pregnancy and cow No. 5167 was in particularly poor condition when treatment commenced. Cow No. 5166 had a mild temperature reaction for five days and recovered besides dropping a healthy calf. The other cow showed diarrhea and aborted. This complication killed the animal.

Test No. 9.—September 14, 1923, Fuga caraballa No. 576 received 100 cubic centimeters cattle reactor serum and 2 cubic centimeters V. B. goat No. 923 (Los Baños) 3 days in the refrigerator. This caraballa developed a good reaction with high temperatures and bloody diarrhea and inappetence for three days but finally recovered. Here again it was shown that goat virus kept three days in a refrigerator retained its virulence.

Test No. 10.—September 27, 1923, Fuga bulls No. 5278 and 5279 received respectively 40 cubic centimeters and 30 cubic centimeters local cattle reactor serum and Fuga caraballa No. 579 was given 80 cubic centimeters carabao reactor serum. Simultaneously each of three animals received 2 cubic centimeters V. B. goat No. 920 (Los Baños) freshly drawn. Oct. 1, 1923, the temperature of the two bulls began to rise, and each was given 50 cubic centimeters additional reactor serum. Six days later the temperatures became normal and the animals recovered completely. The caraballa showed no reaction and on Oct. 8, 1923, it was injected with 25 cubic centimeters of fresh cattle V. B. without untoward results, showing that the animal was immune. One year afterward, the same caraballa was given

25 cubic centimeters fresh cattle V. B. No. 5178, 5485, and 5491 mixed and still no reaction followed.

Test No. 11.—October 1, 1923, Fuga bull No. 5273 received 120 cubic centimeters nonreactor cattle serum and 2 cubic centimeters V. B. goat No. 920 (Los Baños) kept 5 days in a refrigerator. Severe reaction followed for several days, but the animal finally recovered. The animal was in very poor condition after the attack. The object of this test was to see if it was possible to employ nonreactor serum with goat virus by increasing its amount to two or three times the amount of reactor serum ordinarily given.

Test No. 12.—Fuga bulls No. 5284 and 5285 each received 52 cubic centimeters reactor cattle serum and 1 cubic centimeter V. B. goat No. 919, three days in a refrigerator. Caraballa No. 580 was injected with 92 cubic centimeters of the same serum and 2 cubic centimeters of the same V. B. None of the three animals showed any reaction. On October 27, 1923, they were inoculated with 25 cubic centimeters of fresh cattle V. B. No. 63 and 64 mixed but they remained healthy, showing that they were immune.

Test No. 13.—October 27, 1923, Fuga bulls No. 5230, 5257, and 5229 received 45 cubic centimeters, 50 cubic centimeters, and 51 cubic centimeters, cattle reactor serum respectively and 1 cubic centimeter of fresh V. B. from goat No. 917 (Los Baños) simultaneously. The first two bulls showed good temperatures and diarrhea followed by recovery. The last bull had fever for four days but recovered.

One caraballa, No. 574, was given 85 cubic centimeters serum and 2 cubic centimeters of V. B. of the same materials as above. This animal developed good clinical symptoms, but recovered.

From test No. 13 to test No. 16, the reactor serum employed was obtained from reactors which have recovered from the foregoing tests.

Test No. 14.—December 6, 1923, Fuga bulls No. 5237, 5240 and cow No. 5272 received 52 cubic centimeters, 44 cubic centimeters and 58 cubic centimeters reactor serum respectively and 1 cubic centimeter V. B. from goat No. 956 (Los Baños), 24 hours old. The two bulls showed good clinical symptoms, with diarrhea two to three days, but recovered. The cow which received the larger dose of serum showed only high temperatures for six days and recovered. One caraballa, No. 575, was given 76 cubic centimeters carabao reactor serum and 2 cubic centimeters of same V. B. used on cattle. Fever appeared five days after

injection which continued for four days, but she recovered nicely.

Test No. 15.—January 11, 1924, Fuga caraballa No. 577 received 100 cubic centimeters of carabao reactor serum and 1 cubic centimeter V. B. goat No. 952 (Los Baños), 24 hours old and carabao calf No. 586 received 60 cubic centimeters of carabao reactor serum and one-half cubic centimeter of same V. B. No reaction followed. On January 25, 1924, each animal received 25 cubic centimeters cattle V. B. No. 5291. No reaction. These were turned out to pasture with healthy animals for further observation. One year later, January 25, 1925, each animal was given 25 cubic centimeters carabao V. B. No. 594. They remained healthy, showing that they were still immune at the end of one year.

Test No. 16.—January 25, 1924, Fuga bulls No. 5286 and 5287 received 60 cubic centimeters and 55 cubic centimeters of cattle reactor serum and 1 cubic centimeter V. B. goat No. 955 (Los Baños), 18 hours old respetively. One caraballa No. 578 received 95 cubic centimeters of carabao reactor serum and 1 cubic centimeter from V. B. goat No. 955, 18 hours old. Bull No. 5286 had seven days of temperature reaction, and bull No. 5287 showed clinical symptoms, but both recovered. Caraballa No. 578 showed two days slight rise of temperature and recovered easily. Three weeks later, the caraballa received 25 cubic centimeters of cattle V. B. No reaction. The animal was immune.

FIELD NOTES

Four separate groups of native carabaos from the Ilocos provinces the property of the Philippine Trust Co., were immunized simultaneously at different periods beginning July to September, 1926, at the Pandacan Quarantine Station with goat virus. The goats used as virus producers were purchased from Quingua, Bulacan, and were 6 to 12 months old. The average approximate weight of the carabao ranged from 900 pounds to 1,200 pounds.

As in the foregoing tests the virus goats received 10 cubic centimeters virulent cattle blood as infecting agent. At the apex of the thermal reaction they were bled from the jugular a sufficient quantity of blood necessary to inoculate each lot of carabaos being taken. The virulent citrated goat blood thus obtained was used within 24 hours after being drawn from the animal. Hyperimmune cattle serum was employed on all four sets of carabaos.

Lot. No. 1.—July 10, 1926, seventy head of Ilocos carabaoos were injected subcutaneously with 75 cubic centimeters of serum apiece and 1 cubic centimeter goat virus No. 1057, 12 hours old. Of these, thirty-two animals presented good clinical symptoms. In twelve cases temperatures began to rise on the 5th day after inoculation, while in the majority of the animals bloody diarrhea was present for two or three days. After two days of inappetence they began to eat well. An average of 500 cubic centimeters additional serum per animal was given to the reactors during the reaction. July 21, 1926, the remaining thirty-eight that failed to react were reinjected with 15 cubic centimeters fresh cattle virus No. 6104 and no reaction followed showing that they were immune. Reaction, 46 per cent and two deaths. One animal died of severe reaction and another of emphysematous pneumonia.

Control Fuga bull No. 6109 injected with 2 cubic centimeters goat V. B. No. 1057 showed clinical symptoms and was bled to death for rinderpest vaccine.

Lot No. 2.—This lot contained fifty carabaos. On July 30, 1926, each received from 125 cubic centimeters to 140 cubic centimeters hyper-immune cattle serum lot No. 16 and 1 cubic centimeter goat virulent blood No. 1058 drawn on the previous day. Two animals showed thermal reaction and the rest no indications of rinderpest. Four or five days after inoculation, it was noticed that a number of animals passed bloody urine. Microscopic examination of the blood from these animals failed to reveal any causative agent. In some of them bloody urine appeared as late as ten days after inoculation. August 11th, all animals were reinjected with carabao V. B. No. 662 at 15 cubic centimeters each except thirteen that showed hemoglobinuria. No reaction followed. August 25th, hemoglobinuria completely disappeared in the thirteen head and these were then reinjected with 15 cubic centimeters cattle V. B. No. 6238 as above without ill effects.

Lot No. 3.—August 11, 1926, fifty-six carabaos were inoculated simultaneously each receiving 100 cubic centimeters of hyper-immune cattle serum lot No. 17 (Indo-Chinese animals) and 1 cubic centimeter goat virus No. 1059. On the fifth day after inoculation the temperatures in some animals began to rise and in some cases continued for a week or more. Altogether, half of the total number inoculated passed through a good rinderpest reaction. An average of 500 cubic centimeters extra serum was used on each reactor during the course of the disease. Fifty per

cent reaction and no death. August 25th, all nonreactors were given each 15 cubic centimeters fresh cattle V. B. No. 6238 and all proved to be immune.

Control Fuga bull No. 6190 injected with 2 cubic centimeters of goat V. B. No. 1059 showed clinical symptoms and was bled to death for rinderpest vaccine.

Lot No. 4.—August 17, 1926, 97 carabaos were inoculated as follows:

Number of heads that received inoculation	Serum	Lot No.	Goat V. B. No. 1060	Reactors	Percentage
	cc.		cc.		
17	125	17	1	9	52
53	150	17	1	15	38
15	175	17	1	2	13
11	200	17	1	1	9
1	500	17	1		

The lone animal which received 500 cubic centimeters of serum did not react. This animal was suspected to have had rinderpest at the time of inoculation because it had a high temperature; hence the large dose of serum. All the reactors presenting a strong attack were given from 200 cubic centimeters to 300 cubic centimeters additional serum. The reaction was 27 per cent. There were no deaths.

Control Fuga bull No. 6210 injected with 2 cubic centimeters goat V. B. No. 1060 showed clinical symptoms and was bled to death for rinderpest vaccine.

The total mortality in the 273 carabaos immunized was 0.7 per cent.

Charts illustrating various types of temperature reaction.

TEST NO. 11.

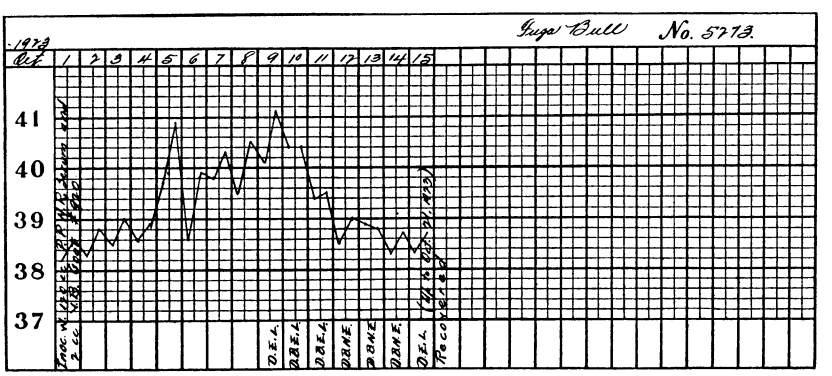

Chart showing reaction in Fuga bull No. 5273. D. E. L.: diarrhea, eating little. D. B. N. E.: bloody diarrhea, not eating.

TEST NO. 13.

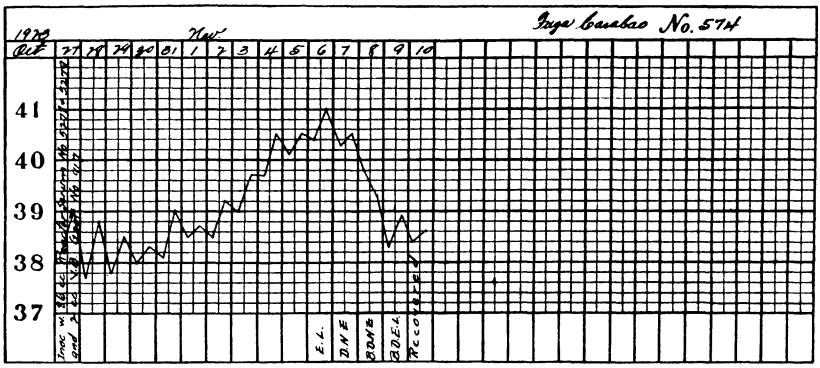

Chart showing reaction in Fuga carabao No. 574. D. E. L.: diarrhea, eating little. D. B. N. E.; bloody diarrhea, not eating.

TEST NO. 14.

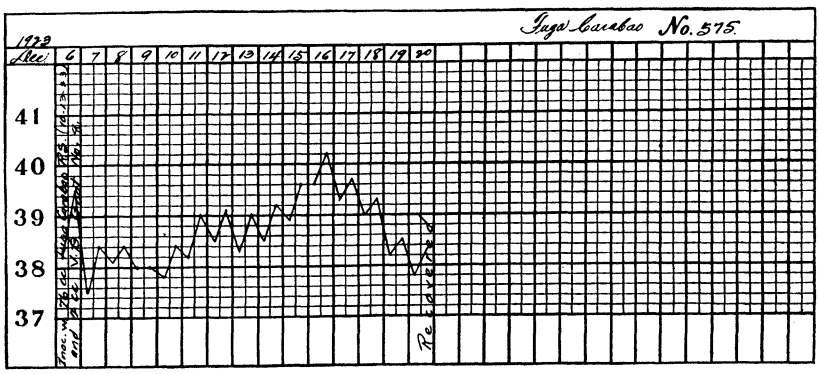

Chart showing reaction in Fuga carabao No. 575.

TEST NO. 14.

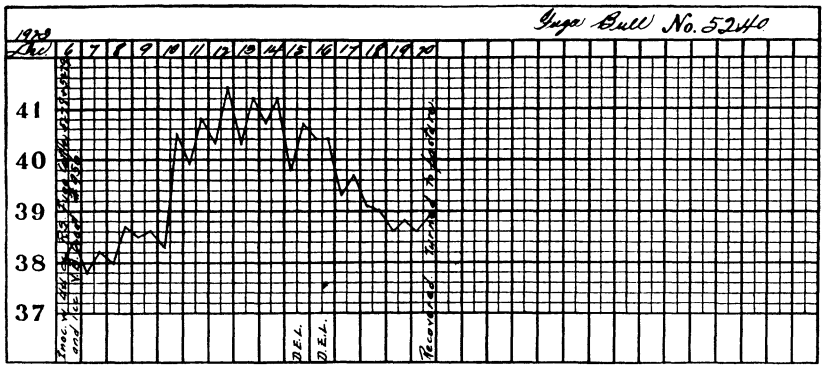

Chart showing reaction in Fuga bull No. 5240. D. E. L.: diarrhea, eating little.

TEST NO. 14.

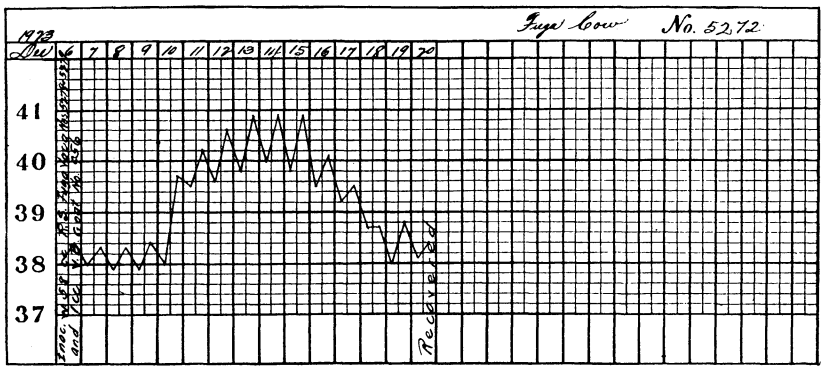

Chart showing reaction in Fuga cow No. 5272.

TABLE I.—*Résumé of tests*

Test number	Date injected	Species	Number	Weight	Serum		Citrated Goat V. B.	Result
					Per 100 lbs.	Actually used		
				Pounds	*Cc.*			
1	May 11, 1923	Cattle	5081	400			25 cc. fresh	Died May 20, 1923.
2	May 28, 1923	do	5083	265	20	60 cc. C. R. S.[1]	5 cc. fresh	Fever 6 days; recovered.
3	July 17, 1923	do	5108	210	20	do	5 cc. 17 hours old	No reaction.
	do	do	5106	270	20	do	do	No reaction. Died of acute tympanitis.
4	Aug. 1, 1923	do	5133	286	20	do	5 cc. fresh	Strong reaction; aborted; died.
	do	do	5139	210	20	do	do	Strong reaction; recovered.
	do	do	5150	270	20	60 cc. Nahtrang	do	Do.
	Control	do	5156	280			do	Strong reaction; bled to death for V. B.
5	Aug. 22, 1923	do	5223	280	20	60 cc. Car. R. S.[2]	5 cc. 40 hours old	Slight temperature; recovered.
	do	do	5224	310	20	do	do	Do.
	Control	do	5225	200			do	Strong reaction; bled to death for V. B.
6	Sept. 6, 1923	do	5182	325	20	60 cc. Nahtrang	5 cc. 24 hours old	Clinical symptoms; recovered.
	do	do	5218	328	20	60 cc. C. R. S.	do	High temperatures; recovered.
7	Sept. 9, 1923	do	2	360			5 cc. 8 days old	Died of typical rinderpest, 9–20–23.
8	Sept. 12, 1923	do	5166	321	20	60 cc. Car. R. S.	2 cc. fresh	Mild reaction; recovered.
	do	do	5167	363	20	do	do	Good reaction, died of complication.
9	Sept. 14, 1923	Caraballa[3]	576	915	10	100 cc. Car. R. S.	2 cc. 3 days old	Clinical symptoms; recovered.
10	Sept. 27, 1923	Cattle	5278	400	10	40 cc. C. R. S.	2 cc. fresh	Temperature reaction; recovered.
	do	do	5279	300	10	30 cc. C. R. S.	do	Do.
	do	Carabao	579	780	10	80 cc. Car. R. S.	do	No reaction.
11	Oct. 1, 1923	Cattle	5273	300	40	120 cc. C. N. R. S.	2 cc. 5 days old	Strong reaction; recovered.
12	Oct. 13, 1923	do	5284	345	15	52 cc. C. R. S.[1]	1 cc. 72 hours old	No reaction.
	do	do	5285	345	15	52 cc. C. R. S.	do	Do.
	do	Carabao	580	920	10	92 cc. C. R. S.	2 cc. 72 hours old	Do.
13	Oct. 27, 1923	Cattle	5230	305	15	45 cc. C. R. S.	1 cc. fresh	Good reaction; recovered.
	do	do	5257	327	15	50 cc. C. R. S.	do	Do.
	do	do	5229	340	15	51 cc. C. R. S.	do	Temperature reaction; recovered.
	do	Caraballa[3]	574	860	10	86 cc. C. R. S.	2 cc. fresh	Good reaction; recovered.
14	Dec. 6, 1923	Cattle	5237	343	15	52 cc. C. R. S.	1 cc. 24 hours old	Clinical symptoms; recovered.
	do	do	5240	292	15	44 cc. C. R. S.	do	Do.
	do	do	5272	392	15	58 cc. C. R. S.	do	Fever 6 days; recovered.
	do	Caraballa	575	760	10	76 cc. Car. R. S.[2]	2 cc. 24 hours old	Fever five days; recovered.
15	Jan. 11, 1924	do	577	820	12	100 cc. Car. R. S.	1 cc. 24 hours old	No reaction.
	do	Carabao calf	586	220	27	60 cc. Car. R. S.	½ cc. 24 hours old	Do.
16	Jan. 25, 1924	Cattle	5286	405	15	60 cc. C. R. S.	1 cc. 18 hours old	Fever 7 days; recovered.
	do	do	5287	370	15	55 cc. C. R. S.	do	Clinical symptoms; recovered.
	do	Caraballa	578	945	10	95 cc. Car. R. S.	do	Fever 3 days; recovered.

[1] C. R. S.—Cattle reactor serum. [2] Car. R. S.—Carabao reactor serum. [3] Caraballa—Female carabao.

NOTE.—All animals which failed to react were given 25 cubic centimeters fresh cattle virus and proved to be immune.

SUMMARY AND CONCLUSIONS

1. The infectiousness of rinderpest-virulent goat blood thru a single passage from cattle to goat has been uniformly established, judging from its effect on our test animals. In one case, the citrated virulent blood kept in the refrigerator remained virulent even after eight days. (See test No. 7.)

2. Judging from the number of recoveries in our test animals, there is evidence that the rinderpest virus had undergone attenuation even thru a single transfer. This is further shown by the type of reaction among the experimental animals. With the cattle virus, at least five or six times the amount of serum employed here would have been required to protect Fuga cattle and carabaos.

3. Further attenuation of the goat virus seems to take place outside the animal body after 24 hours. Several test animals that received freshly drawn virulent blood have shown severe reactions while those which received it after 24 hours, went thru a milder course. (?)

4. One cubic centimeter of citrated virulent goat blood was found quite sufficient to infect the test animals when given with enough physiological salt solution to make a volume of at least 5 cubic centimeters just before inoculation.

5. There is a possibility that by making successive transfers of rinderpest virus thru goats, a certain degree of attenuation may be reached that would further lower the dosage of serum necessary to safely immunize native cattle and carabaos. However, to maintain such type of virus uniformly virulent is another problem that requires further critical study and experimentation because other workers have had varying results.

6. Young goats not more than one year old must be used as virus producers to guard against high resistance in older animals. To obtain a potent virus it is essential that the virus goat be bled at the proper time.

7. An interesting feature in these tests is the thermal reaction which in some test animals persisted up to 9 days—quite a contrast to that occuring when cattle virus is employed.

8. In test No. 11, it has been shown that a nonreactor serum is not safe to use even with the attenuated virus from the goat. Previous tests have established the fact that in general our fresh reactor serum and hyperimmune serum compare favorably with anti-rinderpest sera in other countries as regards potency. It was further noted that there was no appreciable difference

between the efficiency of Nhatrang serum and our reactor serum in test No. 4 and No. 6.

9. From the result in test No. 10, the injection of 50 cubic centimeters additional serum to each test animal on the first rise of temperature seems to have given beneficial effects.

10. The serum used in lot No. 3 was obtained from native cattle and was suspected to act against the red cells of certain carabaos. Captain R. A. Kelser, of the Army Medical Research Board, tested for hemolysin a sample of serum used in lot No. 3, and it was observed that it hemolized the red cells from two carabaos of this lot which were having hemoglobinuria at the time. Whether or not this property was normally present in the serum of native cattle or whether it was brought about as a result of hyperimmunization was not definitely determined. Investigation is under way to elucidate this point.

11. The general results obtained in the four groups of carabaos seem to indicate that the safe dose of serum to immunize them was from 150 cubic centimeters to 200 cubic centimeters per animal. When cattle virus is used, these animals ordinarily require from 350 cubic centimeters to 500 cubic centimeters serum per head at the initial injection.

12. Further work is necessary to arrive at more definite results, particularly as regards the nature of rinderpest virus obtained by several passages thru goats in its application to the simultaneous inoculation of cattle and carabaos, before a standard system can be adopted.

223810——2

SOME OBSERVATIONS ON THE CHARACTERISTIC FEATURES OF THE SKELETON OF THE CARABAO [1]

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INTRODUCTION

The skeleton of the ox has been thoroughly studied and comprehensively compared with that of the horse by Chauveau(1), M'Fadyean(3), and Sisson(4). With the ox as the standard of comparison, these same authorities have also recorded the chief differential, characteristics of the skeleton of the sheep and goat. Likewise, the most salient distinguishing features of the skeleton of the camel has been pointed out by Chauveau. The paranasal or facial sinuses of the sheep have been the subject of investigation by Hopkins(2), and very recently Wilkie(5) published an interesting paper on the auditory ossicles of this animal. But, so far as I have been able to find, no attempt has been made to record the characteristic features of the skeleton of the carabao, the Filipino farmers' most useful work animal.

While, in general, the bones of the carabao resemble those of the other ruminants, especially the ox, there are some anatomical features, as revealed by the present study, that are worthy of notice. To point out the most striking features of the bones of the carabao, as it is believed it will be of interest to students of comparative anatomy, is primary object of this paper.

The data presented here were obtained from the collection of the Department of Veterinary Anatomy, consisting of dried, macerated bones of adult carabaos. In the following description, no attempt is made to give a detailed account of the individual bones; with the ox as the type, unless otherwise specified, only the striking differential features are given. For the purpose of comparison, the bones of the native cows as well as of the Nellore were used, and the illustrations and plan in the textbooks on Veterinary Anatomy on hand were freely consulted in the preparation of this paper.

[1] Submitted for publication, June, 1926.

THE NUMBER OF BONES

The bones that make up the skeleton of adult carabao are 220 in number, as follows:

The Skull:		
Cranial bones		10
Facial bones		21
Auditory ossicles		4
The Vertebral Column:		
Cervical vertebræ		7
Thoracic vertebræ		13
Lumbar vertebræ		6
Sacral vertebræ		4
Coccygeal vertebræ	average	16
The Thorax:		
Ribs	both sides	26
Sternum		1
The Thoracic Limb:		
Shoulder	both sides	2
Arm	do	2
Forearm	do	4
Manus—		
Carpus	do	12
Metacarpus	do	4
Digits—		
Phalanges	do	20
Sesamoids	do	12
The Pelvic Limb:		
Pelvic girdle	both sides	2
Thigh	do	2
Leg	do	6
Pes or hind foot—		
Tarsus	do	10
Metatarsus	do	4
Digits—		
Phalanges	do	20
Sesamoids	do	12
Total		220

In the preceding enumeration the interparietal, mandible, and hyoid are regarded as single bones; the os coxæ is not divided into parts and the average number of coccygeal vertebræ is taken to be sixteen.

THE VERTEBRAL COLUMN

The normal number of bones present in each region of the vertebral column of the carabao is indicated by the formula $C_7T_{13}L_6S_4Cy_{14-18}$.

CERVICAL VERTEBRÆ

These bones are practically of the same length as those of the ox, but they are larger in their other dimensions. The plate of bone connecting the anterior and posterior articular processes on the same side is thicker but less extensive than in the ox; the ridges extending from the posterior articular processes to the spinous processes are more prominent. Both the upper and lower divisions of the transverse processes of the third, fourth, and fifth vertebræ are longer and thicker, but somewhat narrower; the lower division is not only directed downward and forward, but also outward. The transverse processes of the sixth resemble very closely those of the ox, whereas those of the seventh are better developed, and somewhat three-sided; their free ends are very much expanded, and are rough and tuberculate. As with the ox, the foramen transversarium is absent in the transverse process of the seventh. The spinous processes are higher, especially that of the third, which is almost twice as high as that of the ox, and they are less inclined forwards. The summit of the third is not bifid as a rule. The ventral spinous processes of the third, fourth, and fifth are less prominent than in the ox, and usually their thicker posterior part does not project beyond the rim of the cotyloid cavity.

The Atlas.—This vertebra is larger than in any of the other domesticated animals. The tuberosity on its dorsal arch is not as developed as in the ox; it is usually pointed and is situated farther forward. It is continued in front by a ridge which is flanked on either side by a smooth flattened area; the ridge terminates near the anterior border of the dorsal arch. The ventral arch of this bone is relatively thicker but narrower than in the ox and presents a very prominent ventral tubercle, which projects a little way back under the axis. This arch is very much narrower, its antero-posterior width being almost one-half that of the dorsal arch. The anterior articular cavities are very extensive, and are separated above by a wide but shallow notch and below by a narrow deep interval. The posterior articular cavities are likewise extensive. They are more concave from side to side than in the ox, and they are not only continued into the vertebral canal, but are also confluent on the ventral arch.

The wings or alæ of the atlas are very prominent and almost horizontal. They are very much wider behind than before, the

blunt points produced beihnd being about four centimeters from the rim of the posterior articular surface, as compared with about one and a half centimeters in the ox. The posterior border of the wings is continued by a well-defined ridge which terminates at the base of the ventral tubercle and which forms the posterior boundary of the fossa atlantis. As in the ox, the foramen transversarium is absent, but there may be two or more small foramina perforating each wing. It is not rare to observe a piece of bone bridging over the groove connecting the foramen alare and intervertebral foramen on one side.

The axis.—This bone is large and can be distinguished from that of the ox by the following features: the transverse processes are stouter and the dorsal border of the very well developed spinous process is usually straight and very much thickened and tuberculate behind. The spinous process projects further in front than in the ox. The dens is wider and its dorsal surface is not very deeply concave from side to side. The anterior as well as the posterior notches are relatively wider. The intervertebral foramen is very large. The ventral spine is not as prominent as in the ox.

THORACIC VERTEBRÆ

As in the ox and sheep, the thoracic vertebræ in the carabao are thirteen in number. The bodies of these vertebræ are longer and thicker than in the ox, but they are less constricted in the middle, especially in the anterior part of the series. Usually the posterior notches of the arches of the first and the last two bones are never converted into foramina. The transverse processes are stronger and more tuberous, and their facets for the articulation with the tubercle of the rib diminish in size from before backward as in the ox. Sometimes the facts are altogether absent in the last two vertebræ. The mammillary processes are not as prominent as in the ox, and are usually absent in the first and the last vertebræ. The spinous processes are slightly thicker and wider; the third and the fourth are the highest. The ventral crests are rudimentary, and very often they are totally absent in the posterior part of the series.

LUMBAR VERTEBRÆ

The lumbar vertebræ, which are six in number as in the ox, possess longer and thicker bodies, and the construction in the middle is more pronounced. The fifth is the longest of the series; the last is very much compressed dorsoventrally. The

ventral crest is not as distinct as in the ox and is entirely absent in the last vertebra. The transverse processes are relatively long and broad, the first being the shortest, the fifth the longest, and the last, the narrowest. Their borders are markedly sharp and irregular and their intervertebral foramina are relatively large.

SACRUM

This bone is made of four segments only, as in the sheep. Viewed from above, it is more regularly triangular than that of the ox. It is broader and shorter and less curved. The medial sacral crest is very much higher, its highest part being almost twice as high as in that of the ox. The pelvic surface is more concave from side to side, but the central groove indicating the course of the middle sacral artery is very faint and sometimes absent. The anterior articular processes are not as voluminous as in the ox. The promontory is rudimentary, if not altogether wanting. The curve of the articular surface of the body of the first segment is less pronounced in both directions.

COCCYGEAL VERTEBRÆ

The coccygeal vertebræ, fourteen to eighteen in number, resemble very closely those of the ox. In the first six or seven, all the parts of a typical vertebra are present, though more or less rudimentary as they are traced backward. The transverse processes of the first vertebra are relatively better developed, and sometimes the upper part of the anterior border of its spinous process is so united with the medial sacral crest that, at casual observation, it appears as a part of the sacrum.

THE RIBS AND STERNUM

As in the ox, there are thirteen pairs of ribs eight of which are sternal, the remainder asternal. The first is practically of the same length as in the ox, but the others, especially in the posterior part of the series, are relatively longer. In width they all surpass those of the ox. They increase both in length and width from the first to the ninth and tenth and then diminish. The curvature increases in degree to the ninth, remains about the same to the eleventh, and then moderately decreases. It is to be noted that the degree of curvature from the seventh to the thirteenth is usually less than in the corresponding ribs in the ox. The neck is longer and the angle it forms with the shaft is less pronounced. The costal cartilages are similar to those of the ox.

The sternum of the carabao is similar to that of the ox, save that it is placed more obliquely.

The bony thorax presents no special features other than its roof being relatively longer, floor wider, and transverse and vertical diameters greater in its posterior part.

THE SKULL

BONES OF THE CRANIUM

As in the ox, the occipital bone occupies the lower part of the posterior surface of the skull. Taking all the parts as a whole, this bone is much more extensive than in the ox. The external occipital protuberance is less prominent and the median occipital crest extending ventrally from it is commonly very low. The foreman magnum is comparatively wide, and its upper margin is usually notched centrally. The condyles are very massive and less obliquely placed. The paramastoid processes are stronger and wider apart; they are not only convergent as in the ox, but they are also inclined backward. The cerebral surface of the supraoccipital or squamous part presents a better developed internal occipital protuberance, very distinct central depression, and a rather faint groove leading to the temporal canal. The basilar part is relatively wide and strong, but the ventral tubercles it forms with the body of the sphenoid are not very well developed; sometimes they are only rudimentary in character. In an old subject the frontal sinus extends for some distance into the substance of the supraoccipital. The hypoglossal and mastoid foramina and foramen lacerum are similar to those of the ox both in character and position.

The most striking features of the sphenoid bone consists of the relatively deep sella turcica, very well developed dorsum sellae, less extentive bony plate covering the entrance into the optic foramen, and rudimentary sphenoidal sinus.

The ethmoid bone resembles that of the ox. It is not rare to observe, however, the presence of an air-cavity or sinus in its perpendicular part, which communicates with a ventral ethmoidal meatus.

The interparietal bone is similar to that of the ox.

The parietal bones are more extensive than in the ox and they partly concur with the frontals in the formation of the roof of the cranium. The parietal crests separating the temporal fossæ and the posterior surface of the skull are not as salient as in the ox.

The frontal bones are also very extensive. The central frontal eminence formed by the posterior borders of these bones with the parietals in the ox is not present in the carabao. The processus cornus or horn core is comparatively larger than in the ox; it may reached even sixty centimeters (two feet) in length, taking the measurement along its curvature. It is flattened dorsoventrally and gradually tapers to a blunt point. It varies greatly in curvature and direction, but in the majority of the cases, however, the direction is outward and backward. The surface is rough and porous, whereas the interior is excavated to form numerous irregular spaces which communicate with the frontal sinus. The supraorbital foramen is further forward than in the ox and a little nearer to the orbital margin than to the median line. The supraorbital groove is less defined. The orbital and temporal parts of the bone are more extensive. The orbital opening of the supraorbital canal is higher and further forward; it is located a little in front of a transverse plane through the ethmoidal foramen. The distance between the opening and the latter foramen is about two centimeters greater than in the ox. The frontal sinus is very extensive.

The following are the only striking differential features observed in the temporal bones. The temporal crest is less pronounced and the tubercle it forms above the external acoustic meatus is rudimentary, if not altogether absent. The part of the squamous temporal in front of the crest is more extensive but less concave. The zygomatic process is stronger, but the postglenoid process is relatively small. The external acoustic meatus is larger and is directed outward and downward. The bulla ossea bears a comparatively shorter muscular process than in the ox.

BONES OF THE FACE

The maxillary bones of the carabao are characterized principally by the following features: The junction they form with the lacrimal and malar bones is less oblique than in the ox on account of the fact that the facial parts of the latter bones are more or less quadrilateral in outline, as is the case of the sheep; that is, they are not produced to a point anteriorly as in the ox. The facial tuberosity is less developed and further forward, its distance from the infraorbital foramen being about one and a half centimeters shorter than in the ox. The curved line extend-

ing backward from the tuberosity to the malar bone is very ill-defined here and very often only a small portion of it is evident. The maxiliary tuberosity is almost absent. These bones do not present any defect in their nasal wall as in the ox and sheep, since the interval they form with the nasal bone is occupied by the posterior extremity of the nasal process of the premaxilla. The maxillary and palatine sinuses and the maxillary foramen do not differ materially from those of the ox.

The premaxillary bones differ chiefly from those of the ox in that their body is much wider and stronger and that the nasal process is relatively longer; the posterior extremity of the nasal process is fitted into the interval between the maxillary and nasal bones. The palatine fissure narrows to a very acute angle behind as in the sheep. It is not rare to observe the absence of articulation between the palatine process and the maxilla due to the fact that the process is met farther forward by the anterior end of the vomer.

The palatine bones resemble those of the ox, save that the nasal crest is very much better developed and deeply grooved centrally to receive the ventral border of the vomer, and the nasal surface of the perpendicular part is moderately concave from above downward.

The pterygoid bones are more extensive than in the ox. They are much wider above than below and are slightly curved from above downward. The hamulus is fairly thin, sharp and distinctly look-like as in the ox.

The nasal bones are comparatively longer than in the ox and form an articulation with the nasal process of the premaxilla.

The lacrimal bones are relatively small. Their facial surface is less extensive than in the ox, but more or less quadrilateral in outline as in the sheep. The orbital surface which forms part of the medial and front walls of the orbit is only about half that of the ox in extent. The lacrimal bulla and fossa present no differences to attract attention.

The malar bones are also characterized by less extensive facial surface than in the ox. The curved crest below the orbital margin that is constantly present in the ox is not very pronounced here. As in the sheep, the upper part of these bones concur with the lacrimal in the formation of the external lacrimal fossa. The zygomatic process is relatively stronger than in the ox.

Both the dorsal and ventral turbinate bones are similar to those of the ox.

The vomer is comparatively long, having its anterior end usually observed extending about two centimeters in front of the posterior limit of the palatine fissure. Its groove is very much wider and deeper than in the ox. The ventral border is thick and better developed; it is attacked throughout the entire length of the nasal crest formed by the maxillary and palatine bones. In some cases the posterior part of this border is so developed that it completely divided the posterior nares medially.

The mandible of the carabao differs from that of the ox principally in the following points: It is relatively voluminous; the alveoli for the incisors are larger; the rami diverge less, so that the intermandibular space is narrower than in the ox; the angle is more pronounced; and the coronoid processes are relatively long.

The hyoid bone presents nothing to differentiate it from that of the ox.

THE SKULL AS A WHOLE

Apart from larger size, the skull of the carabao offers some features that are distinctly different from those of the ox. The cranium is likewise very extensive externally and more or less quadrangular in outline. Its roof is moderately convex in both directions.

The frontal surface, in addition to the frontals, nasals, and premaxillae, has parts of the parietals for its formation. The central depression found in the frontal part of this surface in the case of the ox is not observed here. The supraorbital foramen is situated further in front than in the ox and further from the frontal suture than from the rim of the orbit. The supraorbital groove is commonly very shallow. The median frontal eminence, a constant feature in the skull of the ox, is altogether absent in the carabao. The processus cornus or horn core which projects from the posterior half of the lateral border of the frontal part, is considerably larger; the zygomatic arches and the supraorbital processes do not possess as much wide curve as in the ox. The nasal part is relatively longer than in the ox; its posterior part is narrower and more convex from side to side than the anterior.

Including the mandible, the lateral surface of the skull of the carabao seems to be more regularly triangular than that of the ox. The temporal fossa is more extensive and extends to some extent to the posterior surface. The parietal crest is very poorly developed. The base of the horn core is so large that the

interval between it and the rim of the orbit is comparatively narrow, being only about one-half that of the ox. The opening of the supraorbital canal into the orbit is higher and further forward. The facial tuberosity is usually less prominent and is situated higher and further forward, and the curved line extending from it to the malar bone is commonly indistinct, if not totally absent. The preorbital region is rather compressed laterally and the infraorbital foramen is higher than in the ox.

The cranial part of the basal surface is much wider transversely than in the ox, and the transverse ridges bounding the occipital condyles in front in the case of the ox are only represented here by very well developed tubercles. The basilar tubercles at the junction of the occipital and sphenoid bones are more or less rudimentary. The bulla ossea is similar to that of the ox, save that it bears a comparatively shorter muscular process. The external acoustic process is directed downward, outward and a little forward. In some cases the posterior nares are completely divided medially by the vomer. The paramastoid processes are stouter and wider apart; they are not only convergent as in the ox, but they are inclined backward. The hard palate is longer and more concave from side to side than in the ox.

The posterior surface is markedly different from that of the ox. It is very much wider below than above and it presents two distinct areas, the nuchal crest, which is lower and better developed than in the ox, being the dividing line. The area above the crest consists of the parietals and interparietal; it is very much the smaller of the two. This area is smooth and almost flattened and is not separated by an eminence or line from the frontal surface. The parietal crests are so poorly developed that the greater part of the temporal fossa can be seen from behind. The external occipital protuberance is less prominent here and there are no distinct lines extending from it laterally as in the case of the ox. Strictly speaking, the area below the nuchal crest is the homologue of the nuchal surface in the ox. This surface is relatively extensive and rough. The foramen magnum is comparatively large and the occipital condyles are more massive and further apart. The mastoid foramen, which is usually very small, has the same position as in the ox, that is, at the junction of the occipital and temporal bones.

As in the ox, the cranial cavity is small, in spite of the great size of the cranium, the discrepancy being accounted for by the very large frontal sinus. The only features observed that distinguish it from that of the ox consists of the following: The olfactory fossae are relatively small but deep; the sella turcica is much deeper; the dorsum sellæ and internal occipital protuberance are better developed; and the bony shelf covering the entrance into the optic foramen is relatively less extensive.

The nasal cavity resembles very closely that of the ox.

The frontal sinus of the carabao is larger than in the ox. In an old subject it may even extend forward to a plane through the margins of the orbits. Laterally, it extends into the roots of the supraorbital processes and to the crests which limit the temporal fossae above; posteriorly, it dips downward to a plane about two and a half centimeters below the nuchal crest. The sinus extends into the processus cormus or horn core almost throughout its entire length. As in the ox, it is separated from its fellow on the opposite side by a complete median septum, and consists of intercommunicating compartments which are subdivided into numerous spaces by bony ridges and trabiculæ.

The maxillary and palatine sinuses, apart from their larger size, do not differ materially from those of the ox.

The sphenoidal sinus is very rudimentary in the carabao and it is confined only in the body of the sphenoid bone as in the case of the ox.

THE BONES OF THE THORACIC LIMB

In general form the scapula of the carabao is similar to that of the ox, but in size it is larger. The spine is relatively higher, less sinuous, and thicker, especially in the middle. The tuber spinæ is very thick and bent backward to a greater degree. The acromion is not as prominent as in the ox. The tuber scapulæ is better developed, but its coracoid process is less pronounced.

Except as to the following features, the humerus resembles that of the ox: It is longer and more massive; the deltoid tuberosity as well as the curved line running from it to the neck is less prominent; the lateral tuberosity is more incurved and presents a thicker posterior part; and the nutrient foramen is usually lower.

The radius is also longer and more voluminous than in the ox. The proximal extremity is relatively broad and the radial

tuberosity is more extensive and mostly confined on the medial half of the dorsal surface. The distal fourth is very massive and more curved; its grooves for the extensor tendons are less salient. The lateral vascular groove connecting the two interosseous spaces that this bone forms with the ulna is usually deeper than in the ox.

As in the ox, the ulna has a complete shaft which is wholly fused with the radius, except at the two interosseous spaces. The only differential features it presents are: the shaft is more curved; the olecranum process is much better developed; and the styloid process is relatively longer.

The carpus consists of six bones—four in the proximal row and two in the distal—as is the case in the ox; the first carpal is absent and the second and third are fused. The bones are larger, otherwise they are similar to those of the ox.

In number the metacarpus does not differ from that of the ox, being made also of a large metacarpal, which results from the consolidation of the third and fourth, and a lateral small metacarpal bone. The large metacarpal is comparatively shorter but much wider than in the ox. The shaft is much wider below than above and its dorsal surface is less convex from side to side. The vertical groove on the dorsal surface is usually fainter than in the ox. The sagittal notch dividing the distal end is wide and deep. The articular surfaces of both the distal and proximal extremities are more extensive, but they do not differ in general form from those of the ox. The small lateral metacarpal bone is very rudimentary, resembling in general form, location, and articulation that of the ox.

The digits are also four in number as in the ox, the first being absent. The third and fourth digits are fully developed and provided with three phalanges and three sesamoids each, while the second and fifth are rudimentary and are provided with only two bones each. The first and the second phalanges are practically of the same length as those of the ox, but in their other dimensions they are larger. The third phalanges, on the other hand, are longer and wider; the slope of their dorsal surfaces is not as steep as in the ox. The interdigital surface is very rough and lengthwise is concave, especially below. The volar surface is more extensive and more concave than in the ox. The extensor process is very rough and prominent. The inferior or ground border presents a wider curve than in the ox; it is continued medially for about two centimeters to join

the border separating the volar and interdigital surfaces. The most anterior part of the ground border is convex from side to side, instead of being pointed as in the case of the ox.

The bones of the second and fifth rudimentary digits are better developed than those of the ox. The sesamoid bones, two proximal and one distal for each developed digit, do not present any striking differential features.

THE BONES OF THE PELVIC LIMB

As compared with those of the ox, the ossa coxarum are larger; the ilia are more oblique with regard to the horizontal plane. The wing of each ilium is relatively larger and its gluteal surface is more concave in front. The gluteal line is less prominent and sometimes it is only represented by rough areas which are scattered irregularly. The auricular surface for the articulation with the sucrum is rather quadrangular in outline, and the ridge separating it from the lateral part is less prominent. The crest or anterior border and the lateral border are somewhat thinner and less concave. The greater sciatic notch is deep. The tuber sacrale is high and usually pointed at the middle; it curves upward and a little outward, and it is separated from its fellow on the opposite side by a narrower interval than in the ox. The tuber coxae is very rough and more prominent, but the psoas tubercle, on the other hand, is less pronounced than in the ox.

With regard to the horizontal plane, the long axis of the ischium is less oblique than in the ox; its pelvic surface is likewise less oblique. The medial border of the body is relatively shorter, and the postero-medial angle is more massive. The postero-lateral angle or tuber ischii is very much flattened, so that the ventral prominence is prolonged considerably inward and backward. The superior ischiatic spine is not as high as in the ox and is usually bent a little inward; it bears fewer vertical lines laterally. The lesser sciatic notch is shallower. The ischial arch is distinctly narrower and shallower than in the ox.

The pubis presents no features that deserve special notice.

Except that they are larger, the acetabulum and the obturator foramen resemble those of the ox.

The anterior aperture or inlet of the pelvis has an average conjugate diameter of about 25 centimeters (10 inches) and a transverse diameter of about 20 centimeters (8 inches). Its obliquity is little greater than in the ox, the difference being

indicated by the fact that the vertical plane from the anterior end of the symphysis cuts the fourth sacral segment about its middle. The cavity is wider than in the ox, the transverse diameter between the middle of the superior ischiatic spines being about 16½ centimeters (6½ inches) to 19 centimeters (7½ inches). The floor of the cavity is also wider and it decidedly less concave in all directions than in the ox.

The femur is more massive, but in other respects it resembles very closely that of the ox.

The tibia is longer and more voluminous than in the ox. The muscular lines on its posterior surface are fewer and less prominent. The sulcus muscularis and the popliteal notch are wider but shallower. The nutrient foramen is usually situated higher and on the lateral border.

The fibula is also very rudimentary, being represented only by two extremities as in the ox. The proximal end is indicated by a small prominence situated below the lateral margin of the lateral condyle of the tibia, while its distal end remains unfused with the tibia and forms the lateral malleolus.

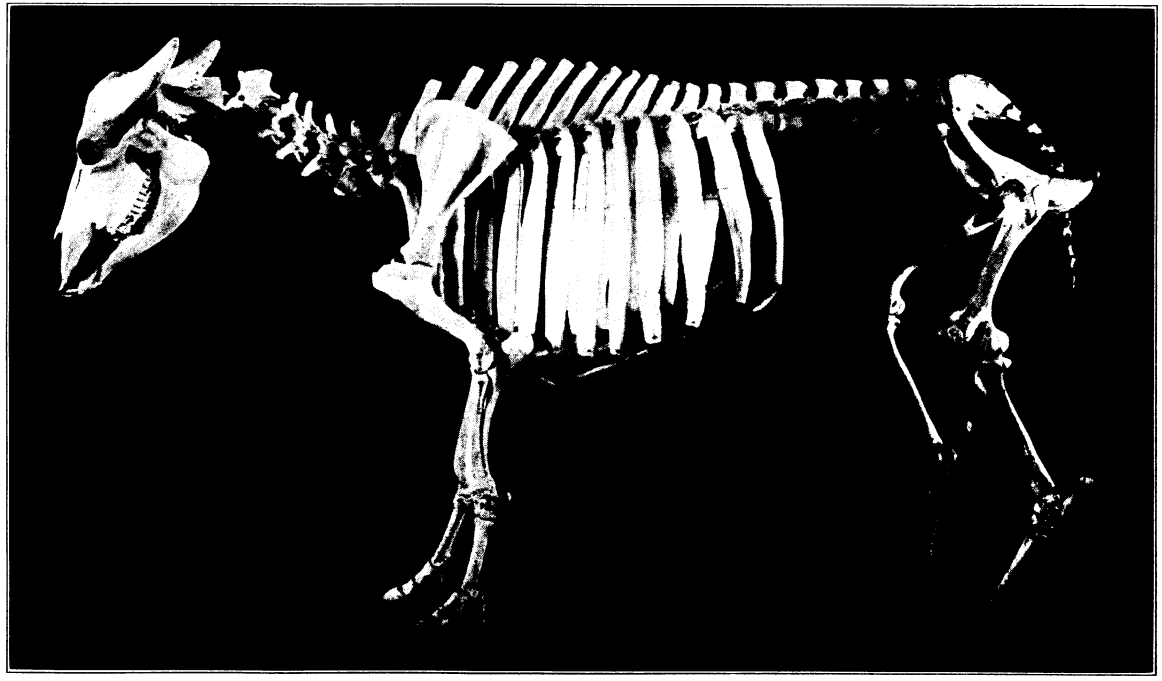
The patella is slightly larger, but otherwise it is similar to that of the ox.

As with the ox, the tarsus consists of five bones, the central and fourth and the second and third being completely fused. The tarsal bones differ from those of the ox only in size.

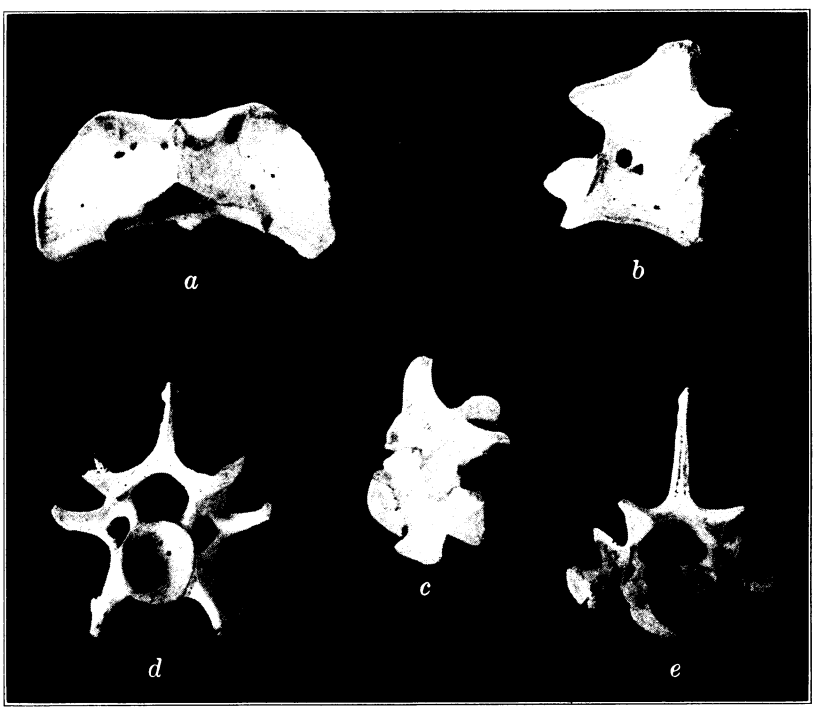
The metatarsus is composed of the large metatarsal and small metatarsal bones. The large metatarsal, which results from the fusion of the third and fourth, is about three centimeters longer than the large metacarpal bone. As compared with that of the ox, however, it is relatively shorter and more massive. The shaft shows better defined dorsal and planter grooves than in the metacarpus.

The small metatarsal is the second metatarsal bone; it is very rudimentary, being represented only by a small disc of about one and a half centimeters in diameter. It articulates with the medio-planter angle of the proximal extremity of the large metatarsal, which has a comparatively small oval facet.

The first and the second phalanges of each chief digit are slightly longer than the corresponding bones in the thoracic limb, but in other dimensions they are little smaller. The third phalanges, on the other hand, are shorter and narrower. The phalanges of the accessory digits and the sesamoids resemble very closely those of the thoracic limb.

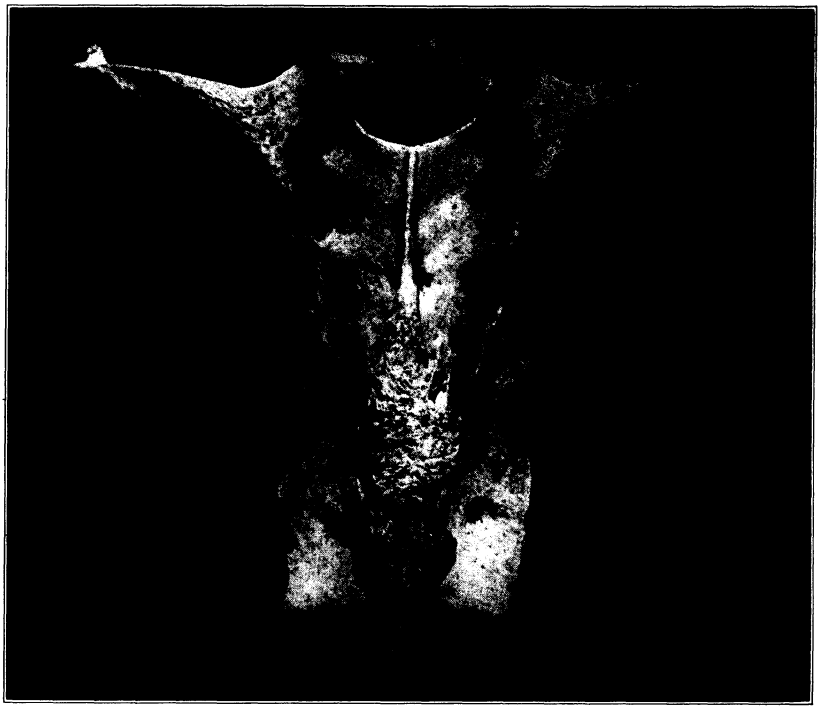


Lateral view of the mounted skeleton of the carabao



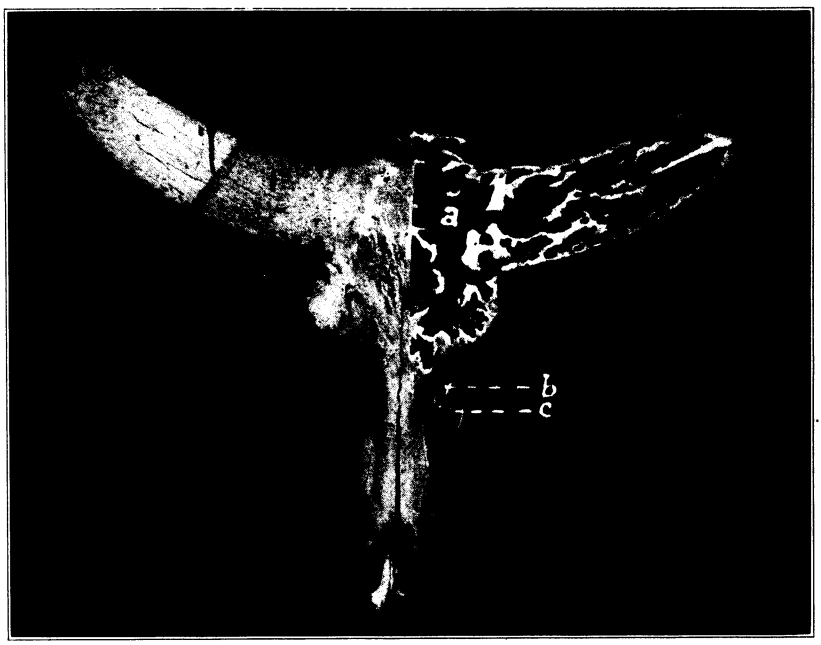
Showing (*a*) dorsal view of the atlas, (*b*) lateral view of the axis, (*c*) lateral view of the third, (*d*) posterior view of the sixth, and (*e*) posterior view of the seventh cervical vertebræ.

Showing (*a*) lateral view of the first, (*b*) antero-lateral view of the eighth, and (*c*) lateral view of the last thoracic vertebræ, (*d*) medial view of the first, (*e*) medial view of the eighth, and (*f*) medial view of the last ribs.



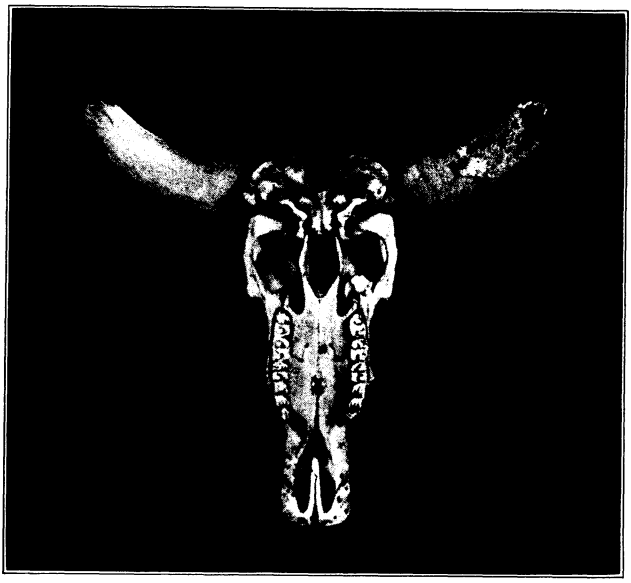
(*a*) Dorsal view of the sacrum

(*b*) Lateral view of the skull



(*a*) Dorsal view of the skull. The outer plate of the bone has been removed to show the left (*a*) frontal and (*c*) maxillary sinuses, and (*b*) part of left osseous lacrimal canal.

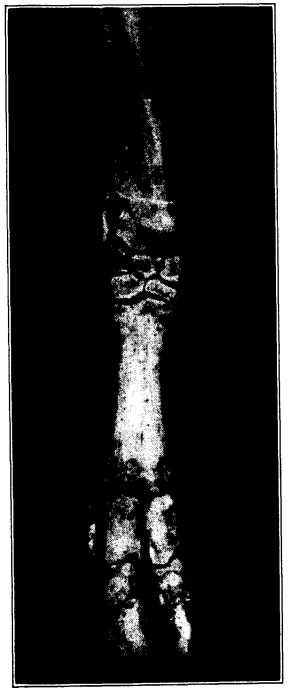
(*b*) Saggital section of the skull without the mandible. Part of the perpendicular part of the ethmoid has been removed to show its lateral mass and the turinate bones. Note (*a*) the very well-developed posterior part of the ventral border of the vomer.



(*a*) Ventral view of the skull without the mandible

(*b*) Posterior view of the cranium without the greater portion of the processus cormus

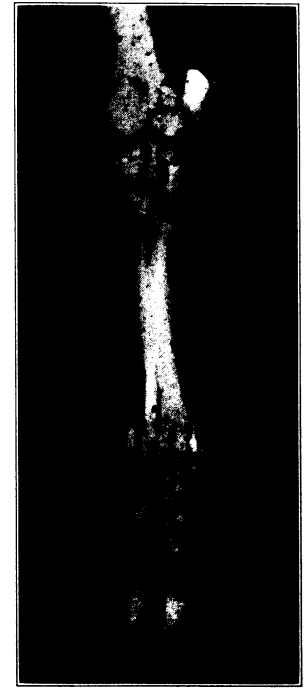
Showing (*a*) lateral surface of the scapula, (*b*) lateral view of the humerus, and (*c*) medial view of the radius and ulna



(*a*) Front view of the carpus, metacarpus and digits

(*b*) Dorsal view of the ossa coxarum

(*a*) Showing (*a*) posterior view of the femur, (*b*) postero-lateral view of the tibia, and (*c*) proximal extremity of the fibula.



(*b*) Antero-lateral view of the tarsus, metatarsus and digits.

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WORM PARASITES OF PHILIPPINE CHICKENS [1]

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A. GENERAL DISCUSSION

INTRODUCTION

Chickens throughout the world are subject to infestation with various sorts of worm parasites, which, according to Gedoelst (1911) and Neveu-Lemaire (1912), number more than fifty species. As some of these parasites are injurious to the health of their hosts and as they may in consequence be a source of loss in poultry-raising, it is a matter of importance to know what particular species of worms occur in native birds and what means may be employed for their elimination and prevention.

The present paper represents an attempt to supply such information and, incidentally, it places on record several species of helminths which have not been previously reported from the Philippine Islands.

INCIDENCE OF DIFFERENT PARASITES

The search for worms infesting Philippine chickens has entailed the examination of ninety-three birds, from which eighteen species of parasites were collected. Although the birds examined were mostly from Los Baños and the neighboring towns in Laguna Province, Luzon, it is believed from what has been observed in chickens obtained from other parts of the Islands that this number of species represents more or less completely the typical worm fauna of Philippine domestic fowls.

The frequency with which the different parasites occur is shown in Table 1. It will be seen that the species most commonly met with are the roundworms, *Gongylonema ingluvicola, Heterakis beramporia, Heterakis gallinæ,* and *Tetrameres fissispina;* and the tapeworm, *Raillietina echinobothrida.*

[1] Submitted for publication, June, 1926.

TABLE 1.—*Showing the frequency of occurrence of different parasites*

[Number of chickens examined: 93]

Parasite	Number infested	Percentage
Amoebotaenia sphenoides	27	29
Davainea proglottina	14	15
Raillietina tetragona	8	9
Raillietina echinobothrida	71	76
Cotugnia digonophora	3	3
Cotugnia sp.	1	1
Weinlandia carioca	36	39
Ascaridia lineata	45	48
Heterakis gallinae	90	97
Heterakis beramporia	91	98
Cheilospirura hamulosa	12	13
Dispharynx spiralis	8	9
Gongylonema ingluvicola	92	99
Tetrameres fissispina	86	92
Oxyspirura mansoni	1	1
Thominx annulata	27	29
Capillaria retusa	30	32

EFFECTS OF PARASITES ON HOST

Although some of the worms infesting chickens have not yet been shown to cause any apparent injury to the health of the host, a large number have been observed to be decidedly pathogenic in their effects. In the case of the pathogenic forms, their effects are produced either directly or indirectly. The effects are indirect if they are produced, not by the parasites themselves, but by certain disease producing microörganisms or viruses which the parasites may introduce into the body of the host. As an example of this indirect pathogenicity may be cited the caecum worm, *Heterakis gallinæ* (= *H. papillosa*), which has been demonstrated by Graybill and Smith (1920), Smith and Graybill (1920), and Tyzzer and Fabyan (1922) to play an important rôle in the production of blackhead in turkeys and chickens. According to these writers, the nematode parasite acts either as an accessory factor that so lowers the resistance of infested birds as to make them susceptible even to light infections with blackhead organisms or as an invertebrate host that is able to transmit the causative agent of the disease from bird to bird.

Another chicken helminth which may possibly be indirectly pathogenic is *Gongylonema ingluvicola,* judging from what has been written in recent years on the rôle played by closely related

parasites in the causation of cancer. In his studies on the epidemiology of the disease, Sambon (1924)) is of the opinion that certain species of *Gongylonema* and other metazoan parasites of mammals are responsible, probably in an indirect manner, for the production of cancerous tumors. Whether or not *Gongylonema ingluvicola* really plays a similar part in the production of a malignant neoplasm in chickens, has, however, not yet been determined.

Regarding the direct effects of parasites, these are brought about by the parasites themselves, as when they set up a condition of malnutrition by continually robbing the host of large amounts of nutritive material from the intestines; when they produce digestive and other disturbances by obstructing the lumen of the intestines and of other canals; when they induce connective tissue cell proliferation to the detriment of other physiologically active cells by acting as foreign bodies; and when they intoxicate the host by elaborating certain poisonous substances during their life or after their death within the body of the host. Of the parasitic worms found in native chickens that may be capable of thus affecting the host may be mentioned the various tapeworms included in Table 1 and the roundworms, *Ascaridia lineata, Heterakis gallinæ, Heterakis beramporia, Capillaria retusa, Thominx annulata,* and *Tetrameres fissispina.*

SYMPTOMS

Any of the worms mentioned above, if present in large numbers, are liable to produce morbid symptoms, which, however, are not characteristic for any species of parasite. The following are usually the general manifestations of a heavy worm infestation in chickens: The bird may eat well, but it gradually wastes away and becomes lethargic. The feathers are usually rough and the wings ruffled and droped. Locomotion is uncertain and the bird makes no attempt to run away when a stranger approaches. If the condition is protracted, a diarrhoea, which is usually fetid in character, appears. The breathing becomes rapid and the appetite irregular. Dullness and somnolence become more evident and the bird shows a tendency to remain for hours in the same position and in the same place with the back humped up and with the eyes half-closed. If it is forced to move, it does so with a painful and staggering gait. If nothing is done to help the bird, it may succumb after one or two months of illness.

DIAGNOSIS

In many cases of worm infestation the symptoms are often so obscure or so general that it is at times difficult to determine, when birds get sick, whether or not the condition is really one of parasitism. Under this circumstance, a diagnosis may be made by eliminating all other possible causes. This procedure, however, is very uncertain and at best it can only point to a suspicion of "worms" or "parasites" without thereby giving any information on the species of worm that is responsible for the trouble. From the viewpoints of treatment and prophylaxis, the determination of the species of the parasite causing the trouble is of the utmost importance, for it is now known that different parasites respond more readily to certain kinds of drugs and that different prophylactic measures are applicable only for certain kinds of worms. A specific diagnosis can be made either by examining under the microscope the droppings of affected birds for parasite ova, the eggs of the various worms having their characteristic shapes, colors, and sizes, by means of which they can be recognized; or by sacrificing one or more sick birds for the purpose of collecting and identifying the adult worms. In the zoölogical section of this paper, the worm parasites of native chickens and their eggs are described and illustrated in order to facilitate their identification.

TREATMENT

Of the many anthelmintics which are used with success for the expulsion of parasites from man and the larger domesticated animals, only a few have been found to be equally effective against the intestinal helminths of fowls. The failure of most of these drugs in chickens is probably due, in part at least, to the fact that in common with other substances they pass through the digestive tract of birds so rapidly that, if given through the mouth, they are eliminated before they have had time to act on the parasites. The following are some of the anthelmintics which have been shown to work positively well in chickens.

Nicotine.—This is used etiher in its original state in tobacco leaf or in the form of nicotine sulphate. It has been tried extensively in several agricultural experiment stations in the United States where it has been found to be very useful for the removal

of the intestinal roundworm of poultry, *Ascaridia lineata*,[1] and the caecum worm, *Heterakis gallinæ*. According to Freeborn (1923), commercial tobacco dust containing from 1½ to 2 per cent nicotine, if fed in the mash of chickens in quantities equaling 2 per cent by weight of the latter over a period of one month, would remove from 98 to 100 per cent of the intestinal roundworms and from 80 to 85 per cent of the caecum worms. It is advised that the tobacco dust be mixed with the mash at intervals not to exceed one week on account of the volatility of the nicotine in the presence of air.

According to the same writer, a 40 per cent nicotine sulphate solution in distilled water mixed in the proportion of 6.6 cubic centimeters to 16 grams of Lloyd's Alkaloidal Reagent (a selected fuller's earth) and placed in gelatin capsules for oral administration, is also effective against Ascaridia. Rectal injections of the same solution diluted at the rate of 1 cubic centimeter of the 40 per cent nicotine sulphate solution to 200 cubic centimeters of distilled water and given in 10 cubic centimeters injections, will remove approximately 85 per cent of the caecum worms.

Recently Graybill and Beach (1925) tested the efficacy of nicotine sulphate in combination with carbon tetrachloride. They found that 3 cubic centimeters of carbon tetrachloride and 0.5 gram of "Blackleaf 40," a proprietory preparation made from tobacco and containing 40 per cent solution of nicotine sulphate, given by the mouth in a gelatin capsule, were nearly 100 per cent effective against Ascaridia.

Oil of chenopodium.—This in combination with a bland oil, like cottonseed oil, was advocated by Hall and Shillinger (1923) for the removal of caecum worms. The mixture is injected through the rectum with a hard rubber enema syringe in doses of 0.1 cubic centimeter oil of chenopodium in 5 cubic centimeters of cottonseed oil for chickens weighing 1.5 pounds and double the amount in oil of chenopodium and bland oil for chickens weighing 3 or more pounds.

[1] According to Schwartz (1925), who determined the presence of *Ascaridia lineata* in the United States, it is a question as to whether or not *Ascaridia galli* (= *Ascaridia perspicillum*), which has been referred to by many American authors in their papers, really exists in America. In view of this finding, I have assumed in this paper that investigators in America before the publication of Schwartz's article confused *Ascaridia galli* with *Ascaridia lineata* and that they must have dealt with the latter species.

Areca nut.—Hall and Shillinger (1923–26) have tried arecoline hydrobromide, which is the bromide salt of the principal alkaloid of the areca nut, against tapeworms of poultry and found it to be ineffective. The failure of the drug was ascribed by the writers to a fact already noted; namely, the speed with which substances in general pass through the alimentary canal of birds.

It was thought possible that if some method of administration were devised by means of which the anthelmintic could be retained longer in the system of fowls satisfactory results could be obtained with the drug. With this object in mind the giving of areca nut powder freshly prepared from the fruits of native trees (*Areca catechu*) for long periods of time was tried. Twelve chickens were confined in a fenced yard, four of them serving as controls in an experiment. All of the birds were given an identical daily ration, except that the eight experimental birds received in addition two mature betel nuts each weighing about 10 grams. The nuts were powdered in a mortar and mixed well with the feed with a little water and the mixture given every morning during the course of the observations. At the end of one to four months, experimental and control chickens were killed and weighed and their intestines examined for parasites. In every instance it was found that the control birds were very much more heavily infested with tapeworms than the experimental birds. In the case of the latter it was evident from the presence of only a few and short specimens of the parasites in the intestines that the area nut was successful in keeping down the cestode infestation to a minimum level which allowed the birds to grow normally and to put on weight. For example, the last batch of birds consisting of 2 control and 3 experimental chickens, when killed and examined at the end of 4 months, furnished the following data:

CONTROL CHICKENS

No. 1. Original weight, 570 grams; last weight, 795 grams. Worms collected: 7 Heterakids, 58 tapeworms (26 *Raillietina echinobothrida,* 11 *Davainea proglottina,* 5 *Amoebotaenia sphenoides,* 16 *Weinlandia carioca*).

No. 2. Original weight, 760 grams; last weight, 930 grams. Worms collected: 13 Ascaridia, 18 Heterakids, about 200 tapeworms (about 50 *R. echinobothrida,* 20 *R. tetragona,* and the rest *W. carioca*).

EXPERIMENTAL CHICKENS

No. 5. Original weight, 595 grams; last weight, 1,065 grams. Worms collected: 4 Ascaridia, 9 Heterakids, 4 tapeworms (*R. echinobothrida*).

No. 8. Original weight, 980 grams; last weight, 1,370 grams. Worms collected: 14 Heterakids, 17 tapeworms (7 *R. echinobothrida*, 10 *W. carioca*).

No. 9. Original weight, 650 grams; last weight, 1,210 grams. Worms collected: 8 Heterakids, 13 tapeworms (*R. echinobothrida*).

Work of a similar nature is still in progress, but so far our findings are indicative of the usefulness of the areca nut against chicken tapeworms, provided the administration of the drug is continued for a long period of time. Against nematodes, it is apparently without much effect, but this fact should not be deplored as there are, as already noted, other anthelmintics which are very efficacious against some of the most dangerous chicken roundworms.

Kamala.—Like the areca nut, the kamala is obtainable locally from the glands and hairs of the capsules of *Mallotus philippinensis*. Hall and Shillinger (1926) tried this drug against chicken tapeworms and found it to be effective in doses of at least 1 gram per chicken.

PREVENTION

Considering the economic value of the animals to be treated and the labor and expense involved in the process, it is clear that the individual treatment of chickens for parasites is not very desirable and, therefor, not recommendable except in special cases. The more practical thing to do is to prevent chickens from getting infested with worms.

Prevention ought to be an easy matter, knowing, as we do, that most worm parasites in their development always start from the stage of an egg which reaches the outside world with the feces of the host. If worm eggs could be destroyed as soon as they reach the ground, or if the feces of the host animal could be so safely disposed of as to prevent the eggs from completing their development, then it would not be difficult to raise chickens and other animals free from parasites. Unfortunately, however, it is as yet impossible to prevent animals from depositing their feces on the ground and this fact renders

the effectiveness of known prophylactic measures only partial. The most that prevention can accomplish is to reduce the intensity of the parasitism by destroying as many worm eggs as possible or by lessening the number of parasite eggs which chickens are liable to pick up from the ground. The following measures should prove useful for the attainment of such a purpose:

(1) The daily collection and burning of chicken feces and the periodical renewal of the surfaces of chicken yards and quarters with fresh clean earth.

(2) The practice of chicken yard rotation, that is, allowing chickens the use of a certain yard for a given length of time (for example, 1 or 2 months) and then transfering them to another yard, which had previously been vacant and kept clean, before the ground of the old yard becomes too saturated with worm eggs.

(3) The destruction of insects and other vermin which serve as the intermediate hosts of chicken parasites, such as garden slugs, the common house fly, and the stable fly, which harbor the infective larval stages of the tapeworms, *Davainea proglottina*, *Raillietina tetragona*, and *Weinlandia carioca* respectively.

(4) The mass treatment of the flock with suitable anthelmintics in order to rid the chickens of, at least, their most dangerous parasites. Nicotine and areca nut, if mixed with the feed as recommended and given together or alternately for a period of one month two or three times a year, should be able to accomplish that object.

B. ZOÖLOGICAL

DESCRIPTION OF PARASITES

As only a very few of the parasitic worms infesting Philippine chickens have previously been reported and as the literature bearing on the different species is scattered and not easily available, the following zoölogical classification and specific diagnoses are included in this paper. In the nomenclature what is believed to be the most nearly valid scientific name of each parasite is used, followed by one or more common synonyms. The descriptions are necessarily brief and short; for more detailed information, the reader may consult the references written under each species of parasite. With the exception of a few figures, the illustrations used in this paper are all original drawings prepared from Philippine material.

Phylum **PLATYHELMINTHES**

Class CESTODA

Family *Davaineidæ* Fuhrmann, 1907.
Subfamily *Davaineinæ* Braun, 1900.

Genus **DAVAINEA** (Blanchard, 1891) Fuhrmann, 1920

Davainea proglottina (Davaine, 1860). Fig. 3.

SYNONYMS.—*D. varians* Sweet, 1910.
D. dubius Meggitt, 1916.

REFERENCES.—Kotlan (1925), Meggitt (1916, 1925), Stiles (1896).

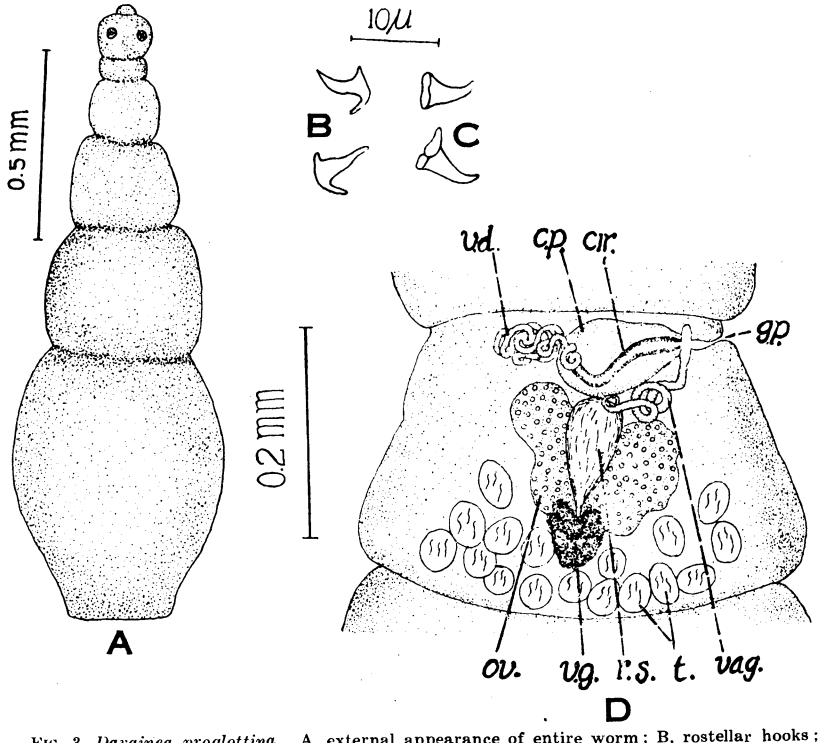

FIG. 3. *Davainea proglottina*. A, external appearance of entire worm; B, rostellar hooks; C, acetabular hooks; D, mature segment. cir., cirrus; c.p., cirrus pouch; g.p., genital pore; ov., ovary; r.s., receptaculum seminis; t., testes; vag., vagina; v.d., vas deferens; v.g., vitelline gland.

Specific diagnosis.—Length, 0.5 to 3 millimeters, depending upon number of proglottids, which may be from 4 to 7, rarely more; maximum width, 0.18 to 0.6 millimeters. Scolex, almost spherical, 0.21 to 0.27 by 0.20 millimeter in size. Rostellum, 0.068 to 0.105 millimeter in diameter, armed with 94 small hammer-shaped hooks arranged in two rows and measuring 0.005 to 0.008 millimeter long. Suckers, 0.042 millimeter in diameter, armed with usually four rows of minute hooks. Neck, absent; first and second proglottids, broader than long; third and, frequently, fourth proglottids, quadrangular; fifth and subsequent proglottids, longer than broad. Genital pores, regularly alternating, at extreme anterior corner of proglottis.

Male genital organs.—Testes, 12 to 19 in number, situated behind female genital organs in posterior half of proglottis; found in second to fourth segment, but showing full development mostly in the third and fourth segments. Cirrus pouch and vas deferens present either in mere beginning, in full development or in regression in almost all segments except in first.

Female genital organs.—Begin to show in third segment, fully developed in fourth, and in regression in fifth. Eggs enclosed singly in capsules formed of parenchym tissue in posterior proglottis, usually fifth; measure 0.035 to 0.049 millimeter in diameter, the oncospheres 0.025 to 0.030.

Location.—Small intestine.

Life history.—Slugs of the genera *Limax* and *Paralimax* have been found to harbor the larval stages of this tapeworm by various authors.

Genus **RAILLIETINA** Fuhrmann, 1920

Raillietina tetragona (Molin, 1858). Fig. 4.

SYNONYM.—*Davainea tetragona* by various authors.
REFERENCES.—Ackert (1919), Gutberlet (1916), Ransom (1904a, 1905), Stiles (1896).

Specific diagnosis.—Length, 10 to 250 millimeters; width, 1 to 4 millimeters, these dimensions varying with the age and state of contraction. Head, 0.175 to 0.350 millimeter in diameter with retractile rostellum, 0.050 to 0.100 millimeter in diameter, armed with a crown of about 100 hooks arranged in a single row. Suckers, oval, 0.050 to 0.090 millimeter in diameter, armed with 8 to 10 rows of hooks. Rostellar hooks, 0.006 to 0.008 millimeter long through longest axis, hammer-shaped, with long ventral root and short dorsal root, and with short and recurved prong. Acetabular hooks, 0.003 to 0.008 millimeter measured through longest axis, with long thorn-like prong. Dorsal root of acetabular hooks very short; ventral root longer than dorsal root but shorter than prong. Neck, long and slender. Segments, trapezoidal and imbricate; edge of strobila, serrate. Ultimate segments usually longer than broad, bell-shaped. Genital pores, unilateral, situated one in each segment, at or in front of middle of lateral margin, frequently marked by a papilla.

Male genital organs.—Testes, 20 to 30 in number, located in median field and surrounding female genital organs, most of

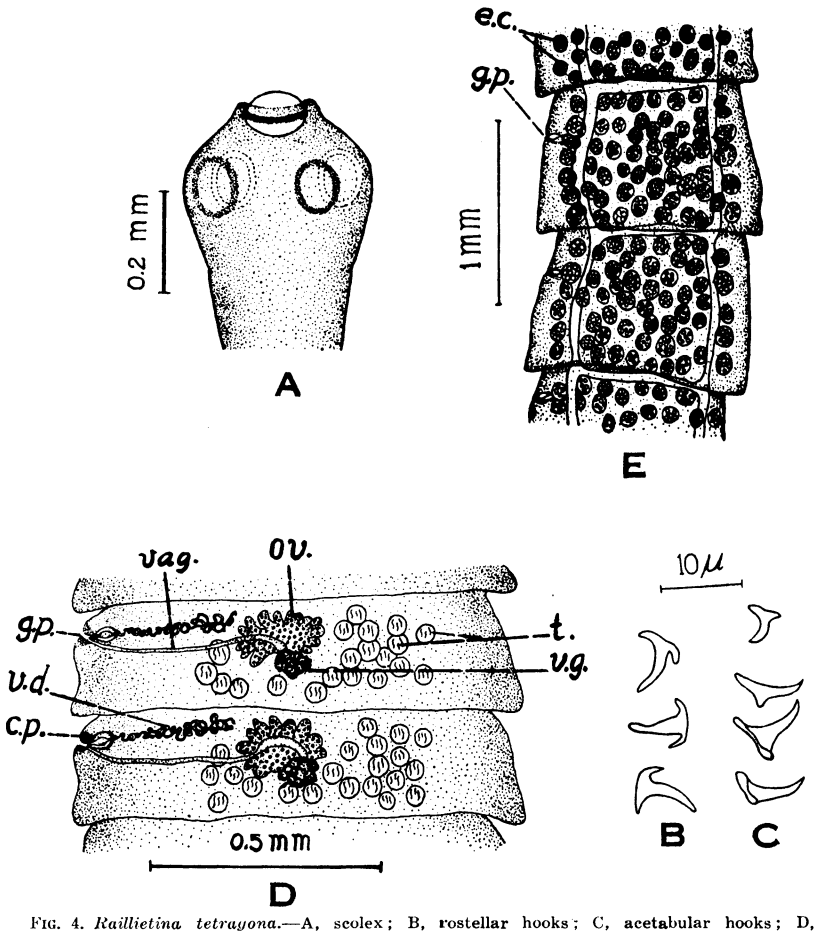

FIG. 4. *Raillietina tetragona*.—A, scolex; B, rostellar hooks; C, acetabular hooks; D, mature segments; E, gravid segments. c.p., cirrus pouch; e.c., egg capsule; g.p., genital pore; ov., ovary; t., testes; vag., vagina; vd., vas deferens; v.g., vetelline gland.

them lying on aporous side of segment. Vas deferens lies in anterior third of segment, begins in median line, and extends in a much convoluted course laterally to base of cirrus pouch, which it enters, and after a few coils in basal portion of latter becomes transformed into the cirrus. Cirrus pouch, pyriform, 0.075 to 0.100 millimeter long. Cirrus without apparent spines.

Female genital organs.—Ovary in middle of segment. Yolk gland, posterior of ovary, irregularly reniform, slightly longer in its transverse axis, about 0.100 millimeter in diameter. Shell gland, prominent, 0.050 millimeter in diameter, immediately in front of yolk gland. Receptaculum seminis, absent, a portion

of vagina being dilated and functioning as seminal receptacle. A definite and persistent uterus not developed. The eggs as they pass from the distal end of the oviduct become embedded in a fibrous and granular mass, which generally fills up most of the segment. This mass divides into 50 to 100 portions to form egg capsules, each surrounded by a membrane and containing 6 to 12 or more eggs. Eggs surrounded by 3 envelopes—an inner envelope close to the oncosphere, a middle folded, and an outer smooth. Oncospheres measures 0.010 to 0.014 millimeter in diameter; the eggs with the outer envelop intact, 0.025 to 0.050 millimeter.

Location.—Small intestine.

Life history.—According to Ackert (1919), the intermediate host of this tapeworm is the common house fly (*Musca domestica*).

Raillietina echinobothrida (Megnin, 1880). Fig. 5 and plate 1.

SYNONYM.—*Davainea echinobothrida* by various authors.
REFERENCES.—Gutberlet (1916), Ransom (1904 a, 1905), Stiles (1896).

Specific diagnosis.—Length, up to 250 millimeters; width, 1 to 4 millimeters. Head, 0.250 to 0.450 millimeter in diameter; with retractile rostellum armed with a crown of about 200 hooks arranged in 2 ranks. Suckers, round or oval, 0.090 to 0.200 millimeter in diameter, armed with 8 to 10 rows of hooks. Rostellar hooks similar in type to those of *Raillietina tetragona,* but larger, measuring 0.010 to 0.013 millimeter in length. Acetabular hooks likewise similar to those of *R. tetragona,* but also larger, measuring 0.006 to 0.015 millimeter in length. Neck, generally thicker and shorter than that of *R. tetragona,* frequently equal in width to head. Strobila resembling that of *R. tetragona,* but with serrate border more pronounced. Ultimate segments, at least in preserved specimens, differ from those of *R. tetragona* by being less elongate and frequently marked by median constrictions which give rise to a series of median openings through posterior portion of strobila. Genital pores, irregularly alternate, or sometimes almost entirely unilateral, situated one in each segment posterior of middle of lateral margin.

Male genital organs.—Testes, 20 to 30 in number, arranged as in *R. tetragona.* Vas deferens similar to that of R. tetragona.

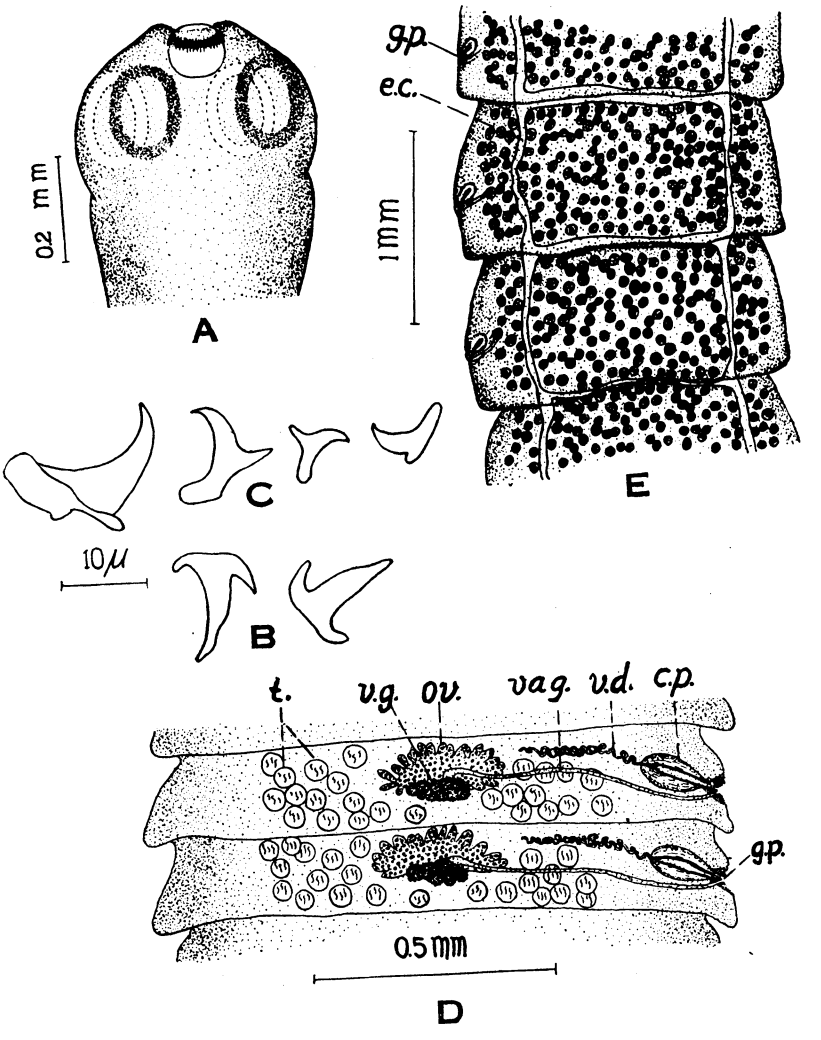

FIG. 5. *Railietina echinobothrida*. A, scolex; B, rostellar hooks; C, acetabular hooks; D, mature segments; E, gravid segments. c.p., cirrus pouch; e.c., egg capsule; g.p., genital pore; ov., ovary; t., testes; vag., vagina; v.d., vas deferens; v.g., vitelline gland.

Cirrus pouch, flask-shaped, 0.130 to 0.180 millimeter in length. Cirrus appears to be armed with minute spines.

Female genital organs.—Female organs as in R. tetragona. Eggs similar in size and structure.

Location.—Small intestine; sometimes caeca.

Life history.—Unknown. Certain kinds of snails have been suspected to act as intermediate hosts.

Raillietina tetragona and *R. echinobothrida* are quite similar in appearance and are, therefor, likely to be confused. They can be readily differentiated, however, by the fact that the head, rostellum, suckers, and hooks of *R. echinobothrida* are larger than those of *R. tetragona.* In *R. echinobothrida* the genital pores are usually irregularly alternate and situated posterior of the middle of the lateral margin of the segment, while in *R. tetragona* the genital pores are usually unilateral and situated at or in front of the middle of the lateral margins of the segments. The cirrus pouch of *R. echinobothrida* is larger and flask-shaped, while that of *R. tetragona* is smaller and pyriform in shape. In pathogenicity *R. echinobothrida* differs from *R. tetragona,* the former being responsible for the production of intestinal nodules and ulcers in chickens.

Genus COTUGNIA Diamare, 1893

Cotugnia digonophora (Pasquale, 1890). Fig. 6.

SYNONYM.—*Taenia digonophora* Pasquale, 1890.
REFERENCES.—Meggitt (1920), Stiles (1896).

Specific diagnosis.—Length, 22 to 107 millimeters; width, 1 to 4 millimeters. Scolex, 0.66 by 1.07 millimeters in size, provided with a rostellum armed with 2 rows of hooks 0.008 to 0.012 millimeter long. Suckers, unarmed, 0.36 by 0.25 millimeter in size. Neck, short. All proglottids broader than long. Two complete sets of genital organs. Genital pores situated halfway along each lateral margin of segment or slightly anterior of that level.

Male genital organs.—Testes, about 100 in number, arranged in a broad band across proglottis and lateral to longitudinal excretory vessels, posterior of level of ovary. Cirrus pouch, long and slender, armed with fine spines according to Meggitt (1920). Vas deferens runs posteriorly from cirrus pouch.

Female genital organs.—Ovary, lobulated, lying immediately internally to corresponding longitudinal excretory vessel, halfway between anterior and posterior borders of proglottis. Vitelline gland, posterior of ovary. Shell gland, compact, not lobed, situated on dorsal surface between ovary and vitelline gland. Vagina opens posteriorly of cirrus. A definite uterus not developed. Eggs, ellipsoidal, 0.063 by 0.058 millimeter in size; oncospheres, 0.028 by 0.024.

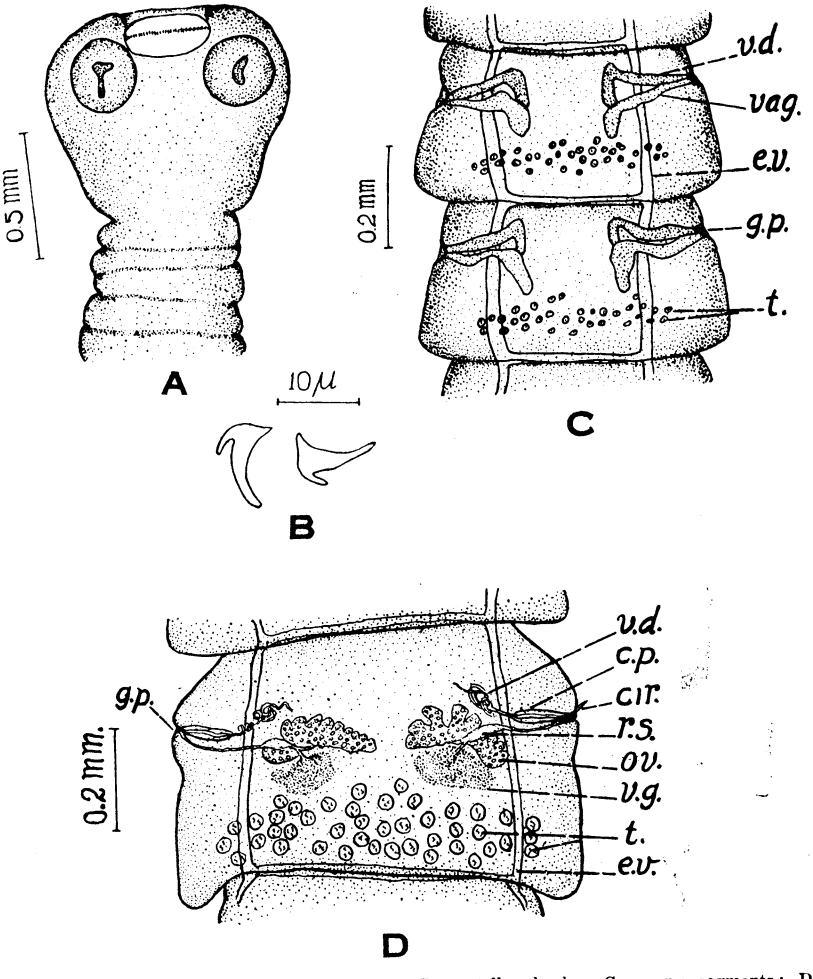

FIG. 6. *Cotugnia digonophora*. A, scolex; B, rostellar hooks; C, young segments; D, mature segment. cir., cirrus; c.p., cirrus pouch; e.v., excretory vessel; g.p., genital pore; ov., ovary; r.s., receptaculum seminis; t., testes; vag., vagina; v.d., vas deferens; v.g., vitelline gland.

Location.—Small intestine.

Life history.—Unknown.

Cotugina sp. Fig. 7.

This is represented by a single specimen in the helminthological collection of the College of Veterinary Science, University of the Philippines. Unfortunately, there are no gravid segments available for study and the scolex only show an unarmed rostellum, the hooks evidently having been lost. For this reason

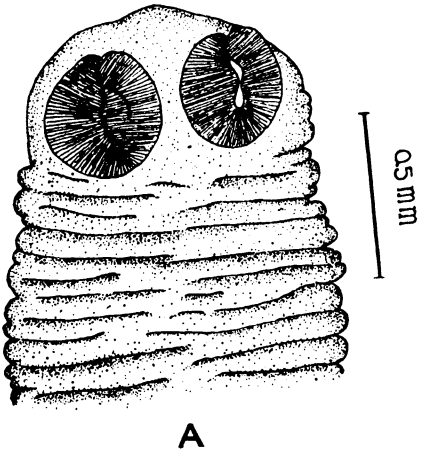

FIG. 7. *Cutugnia* sp. A, scolex; B, mature segment. cir., cirrus; c.p., cirrus pouch; e.v., excretory vessel; g.p., genital pore; ov., ovary; r.s., receptaculum seminis; t., testes; vag., vagina; v.d., vas deferens; v.g., vitelline gland.

it cannot be assigned definitely to any species. It differs, however, in important characters from *Cotugnia digonophora* and from other species of the genus, the descriptions of which are available to the writer, by the number and position of the testes and the appearance of the cirrus pouch.

Specific diagnosis.—Length, 60 millimeters and over; width, 1 to 3 millimeters. All proglottids wider than long, the proportion of width to length in most anterior segments being 5 to 1 and in posterior segments 1.5 to 1. Scolex, 0.5 by 0.8 millimeter

in size. Suckers, unarmed, 0.4 by 0.36 millimeter in size. Two complete sets of genital organs. Genital pores located anterior of middle of each lateral margin of segment.

Male genital organs.—Testes, about 200 in number, occupying most of the space enclosed by excretory vessels not otherwise occupied by other organs and also lateral of longitudinal excretory vessels posterior of ovaries. Cirrus pouch, 0.37 millimeter long, bent anteriorly, extending inwardly as far as longitudinal excretory vessel. Vas deferens coiled loosely.

Female genital organs.—Ovary, relatively small, composed of distinct acini, located internally of longitudinal excretory vessel anterior of equator of segment. Vitelline gland, posterior and internal of ovary. Shell gland diffuse. Receptaculum seminis, present. Eggs, unknown.

Location.—Small intestine.

Life history.—Unknown.

Family *Hymenolepididæ* (Ariola, 1899).
Subfamily *Hymenolepidinæ* (Perrier, 1897).

Genus **WEINLANDIA** Mayhew, 1925

Weinlandia carioca (Magalhaes, 1898). Fig. 8.

SYNONYM.—*Hymenolepis carioca* by various authors.
REFERENCES.—Gutberlet (1919), Mayhew (1925), Ransom (1902, 1905).

Specific diagnosis.—Length, 30 to 80 millimeters; width at neck, 0.075 to 0.150 millimeter and at posterior end, 0.500 to 0.700 millimeter. Segments broader than long throughout strobila. Head, flattened dorso-ventrally, 0.140 to 0.160 millimeter long, 0.150 to 0.215 millimeter wide, and 0.100 to 0.140 millimeter thick. Suckers, shallow, unarmed, 0.070 to 0.090 millimeter in diameter. Rostellum, unarmed, with a small pocket opening to exterior in its anterior portion; size in retractile position, 0.090 to 0.100 by 0.025 to 0.040 millimeter. Neck, 0.6 to 1.5 millimeters long. Genital pores almost entirely unilateral, a single pore being located in each segment slightly in front of middle of its right hand margin.

Male genital organs.—Testes, 3 in number, normally 2 on left and 1 on right, of medium line. Cirrus pouch in sexually mature segments, 0.120 to 0.175 by 0.015 to 0.018 millimeter in size, almost cylindrical, slightly curved toward ventral surface of segment. On dorsal side of inner end of cirrus pouch, vas deferens is swollen into a prominent seminal vesicle.

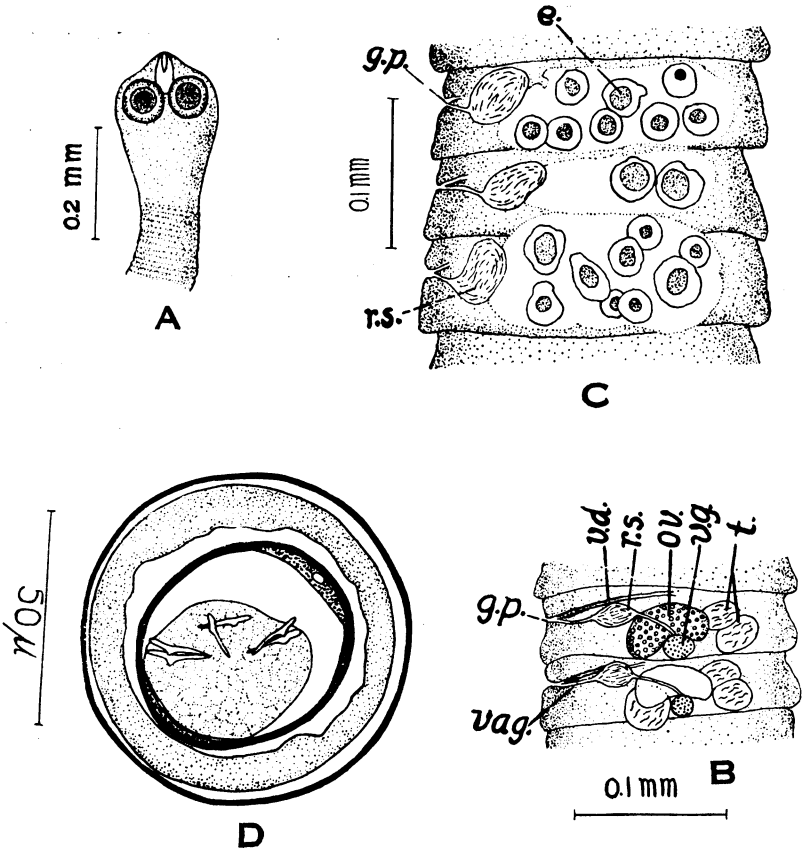

FIG. 8. *Weinlandia carioca.* A, scolex; B, mature segments; C, gravid segments; D, oncosphere with membrarens. e., egg; g.p., genital pore; ov., ovary; r.s., receptaculum seminis; t., testes; vag., vagina; v.d., vas deferens; v.g., vitelline gland.

Female genital organs.—Opening of vagina in floor of genital cloaca, ventral and posterior of cirrus opening. Vagina at first very narrow, but gradually increases in diameter and in sexually mature segments is swollen out into a prominent seminal receptacle, extending forward to anterior border of segment and inward a considerable distance beyond proximal end of cirrus pouch. Ovary, faintly bilobed or trilobed, in posterior half of proglottis, extending across segment when fully developed. Yolk gland, spherical or ovoid, situated near median line of segment, and posterior and dorsal of ovary. Uterus at first a solid cord of cells extending transversely across segment along anterior border of ovary; then it becomes hollowed out and grows backward on dorsal side of ovary; in gravid seg-

ments it occupies nearly entire segment and is filled with eggs. Eggs in gravid uterus, spherical or oval, with 4 thin membranes, the 2 middle membranes often approximated to form a single membrane. Measurements of these membranes as follow: outer, 0.036 to 0.075 by 0.036 to 0.070 millimeter; outer middle, 0.030 to 0.065 by 0.030 to 0.060; inner middle, 0.026 to 0.040 by 0.026 to 0.035; inner, 0.024 to 0.029 by 0.016 to 0.021. Oncospheres, 0.018 to 0.027 by 0.014 to 0.019 millimeter in size. Embryonal hooks, 0.010 to 0.012 millimeter long.

Location.—Small intestine.

Life history.—According to Gutberlet (1919), the intermediate host of this tapeworm is the stable fly, *Stomoxys calcitrans.*

Subfamily *Dilepinae* Fuhrmann, 1907.

Genus **AMŒBOTÆNIA** Cohn, 1899

Amœbotænia sphenoides (Railliet, 1892). Fig. 9.

SYNONYMS.—*Taenia cuneata* von Linstow, 1872.
Taenia sphenoides Railliet, 1892.

REFERENCES.—Meggitt (1914), Stiles (1896).

Specific diagnosis.—Length, 2 to 4 millimeters; width, 1 millimeter. Scolex, 0.14 to 0.20 by 0.16 to 0.20 millimeter in size; rostellum, 0.15 to 0.17 by 0.03 to 0.04 millimeter in size, armed with characteristically-shaped hooks 0.025 millimeter long. All proglottids, 13 to 24 in number, broader than long. Genital pores, regularly alternate, situated at anterior sixth or almost at anterior corner of segments.

Male genital organs.—Clearly recognizable in third segment, although second segment already shows traces of them. Testes, 12 in number, lying in single row on dorsal surface of posterior end of proglottis. Cirrus pouch, straight, narrow. Vesicula seminalis, absent, coils of vas deferens being dilated and functioning as seminal vesicle.

Female genital organs.—Traces of these organs first appear in fourth segment and persist in fully-developed condition as far as fourteenth segment. Ovary, bilobed, lying on ventral surface of proglottis, a little to one side of median line and half-way between anterior and posterior borders. Vitelline gland, compact, disc-shaped, lying posterior of ovary. Receptaculum seminis, present. Uterus, persistent. Eggs, 0.029 to 0.042 millimeter in diameter.

Location.—Small intestine.

Life history.—It is assumed, based from the observations of Grassi and Rovelli (1892), that the intermediate hosts of this

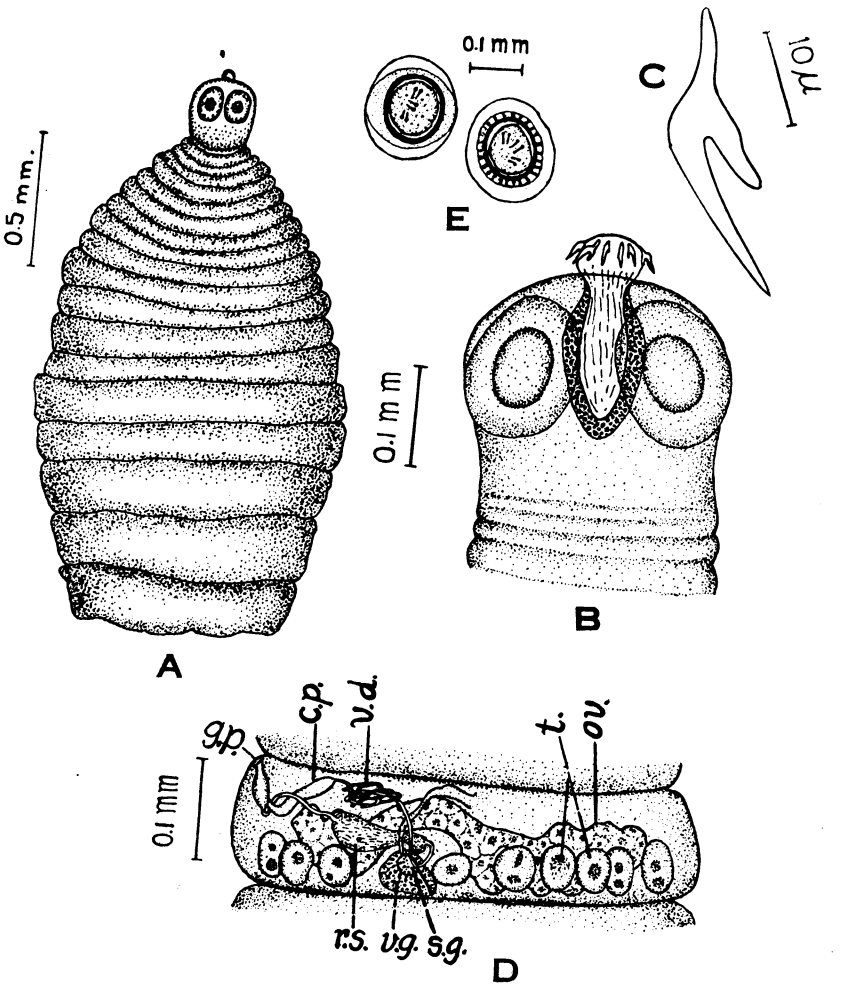

FIG. 9. *Abœbotaenia sphenoides.* A, external appearance of entire worm; B. scolex; C, rostellar hook; D. mature segment; E. oncospheres with membranes. c.p., cirrus pouch; g.p., genital pore; ov., ovary; r.s., receptaculum seminis; s.g., shell gland; t., testes; v.d., vas deferens; v.g., vitelline gland.

tapeworm are brandlings, *Allolobophora fœtida,* and species of *Pheritima.*

Phylum **NEMATHELMINTHES**

Class NEMATODA

Superfamily *Ascaroidea* Railliet and Henry, 1915.
Family *Heterakidæ* Railliet and Henry, 1914.

Genus HETERAKIS Dujardin, 1845

Heterakis gallinæ (Gmelin, 1790). Fig. 10.

SYNONYMS.—*H. papillosa* (Bloch, 1782).
H. vesicularis (Froelich, 1791).
REFERENCES.—Graybill (1921), Uribe (1922).

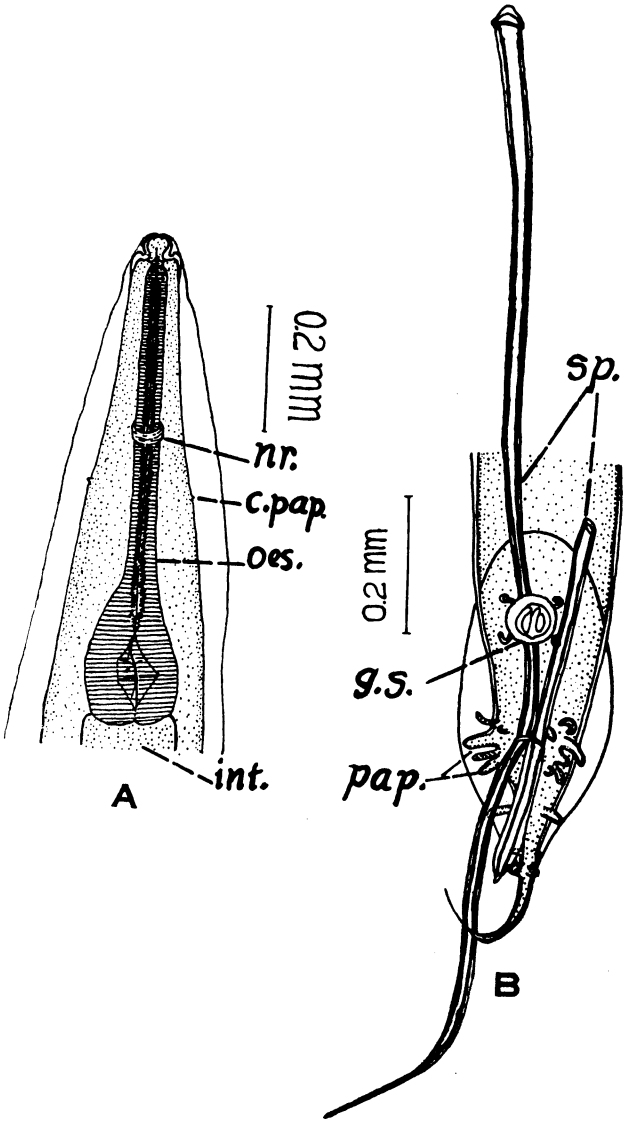

FIG. 10. *Heterakis gallinae*. A, ventral view of anterior end of body; B, ventral view of posterior end of male. c.pap., cervical papilla; g.s., genital sucker; int., intestine; nr., nerve ring; oes., œsophagus; pap., genital papillæ; sp., spicules.

Specific diagnosis.—Small, slender worm of a whitish color; with two lateral longitudinal ridges arising from a point near anterior extremity and terminating at posterior end in female in a flattened elongated tail and in male in a copulatory bursa. Mouth orifice followed by a short and narrow cavity, on walls of which and near oral aperture are three indistinct teeth and at bottom three other very small teeth projecting vertically toward mouth opening. Mouth with three lips of equal size, of which one is dorsal and two ventral. Ventral lips with two small, inconspicuous papillæ. Œsophagus, about 1 millimeter long, composed of two parts—a short anterior portion and a longer posterior portion dilated distally to form œsophageal bulb. Cervical papillæ, inconspicuous, at or slightly anterior of middle point of œsophagus. Nerve ring, a short distance in front of cervical papillæ. Excretory pore, between cervical papillæ and nerve ring.

Male.—Seven to eight millimeters long. Copulatory bursa supported by 12 pairs of papillæ arranged in three groups—an anterior group of two pairs of ventral papillæ, the anterior pair being anterior and the posterior pair posterior of middle of sucker; a second group of two pairs of ventral and four pairs of lateral papillæ, all in the immediate neighborhood of anus; a third group of one pair of ventral and three pairs of lateral papillæ toward tip of tail. Sucker, 0.060 millimeter in diameter, provided with a circular chitinous rim and showing a papilliform nodule in its posterior border. Spicules, very dissimilar—left spicule, short, 0.65 millimeter in length or approximately one-third of length of right spicule which attains a length of 2 millimeters. Spicules enclosed in separate sheaths. Shorter spicule, tubular, with two lateral flanges and with a characteristically-twisted tip; longer spicule, also tubular, but with only one flange and with a short straight tip. Anus, about 0.26 millimeter from tip of tail.

Female.—Eight to fifteen millimeters long. With a double system of ovaries, oviducts, and uteri. Vulva, a little posterior of middle portion of body. Anus, about 1 millimeter from tip of tail. Eggs, with smooth thick shell, 0.068 to 0.075 by 0.036 to 0.038 millimeter in size.

Location.—Cæca.

Life history.—Direct. According to the observations of Graybill (1921) and Uribe (1922), the larvæ, which hatch from the

eggs, do not migrate to other parts of the body of the host, but remain in the cæca to complete their development.

Heterakis beramporia Lane, 1914. Fig. 11.

REFERENCES.—Arkert (1920, 1923), Schwartz (1925 a).

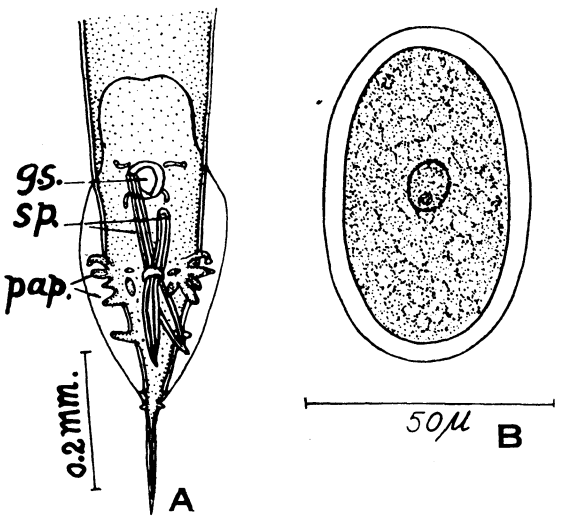

FIG. 11. *Heterakis beramporia*. A, ventral view of posterior end of male; B, egg. g.s., genital sucker; pap., genital papillæ; sp., spicules.

Specific diagnosis.—Quite similar in external appearance and in other characters to *H. gallinæ*, but smaller. Œsophagus, 0.630 to 0.745 by 0.12 to 0.15 millimeter in dimensions. Excretory pore, 0.309 to 0.345 millimeter; nerve ring, 0.205 to 0.242 millimeter, from cephalic end. Cervical papillæ, 0.01 to 0.03 millimeter posterior of excretory pore.

Male.—5.2 to 5.5 millimeters long by 0.25 millimeter in maximum width. Sucker, circular, 0.055 to 0.064 millimeter in diameter. Bursa supported by 12 pairs of genital papillæ arranged in nearly identical manner as in *H. gallinæ*. Spicules, nearly equal in length but of different shapes—right spicule, 0.35 to 0.70 millimeter long, with a tapering point; left spicule, 0.30 to 0.60 millimeter long, bearing a prominent angle on its ventral aspect.

Female.—6.3 to 6.7 millimeters long by 0.225 to 0.300 millimeter in maximum width. Vulva located somewhat posterior of equator of body. Immediately caudad of vulva is a cuticular

flap projecting over opening. Anus, 0.067 to 0.068 millimeter from tip of tail. Eggs, with smooth thick shell, 0.050 to 0.060 by 0.025 to 0.030 millimeter in size.

Location.—Cæca.

Life history.—Presumably similar to that of *H. gallinæ* with respect to the nonmigration of larvæ to other parts of the body of the host.

Schwartz (1925), who called attention to the presence of a type of intestinal nodules in chickens, is of the opinion that they are due to the invasion of the cæcal walls by heterakid larvæ, which were identified as those of *Heterakis beramporia* because they were associated with the adult worms of that species. The present writer has observed similar nodules in most of the chickens examined and found them to be associated with either *H. gallinæ, H. beramporia* or both. It is suspected, therefor, that the formation of the nodules may be due to the invasion of the cæcal wall by larvæ of both species of worms.

Genus ASCARIDIA Dujardin, 1845

Ascaridia lineata (Schneider, 1866). Fig. 12 and plate 2.

SYNONYMS.—*Heterakis lineata* (Schneider, 1866).
Ascaridia perspicillum and *A. galli* of most American authors.

REFERENCES.—Lane (1914) Schwartz (1925 b, c).

Specific diagnosis.—Mature specimens, 70 to 120 millimeters long by about one or more millimeters wide, the females being larger than the males. Lips, prominent, each lip provided with 2 papillæ and a dentigerous ridge bearing distinct teeth. Œsophagus, simple, 3 to 4 millimeters long by 0.34 millimeter wide. Nerve ring, located approximately anterior to first fourth of œsophagus, and excretory pore posterior of nerve ring.

Male.—Ten pairs of genital papillæ arranged in three groups as follows—an anterior group of three pairs of ventral papillæ arranged on each side of sucker, the middle pair of this group of papillæ being alongside, the anterior pair being on level with or anterior to, and the posterior pair being posterior to, sucker; a second group of three pairs of lateral and one pair of ventral papillæ, all being postanal in position with occasional variations, in which the first lateral pair of papillæ may be on the level with or somewhat anterior of anus; a third group of two pairs of lateral and one pair of ventral papillæ in the region of tip of tail. Spicules, equal, variable in size—minimum length, 0.54 millimeter in young forms; maximum length, 2.4

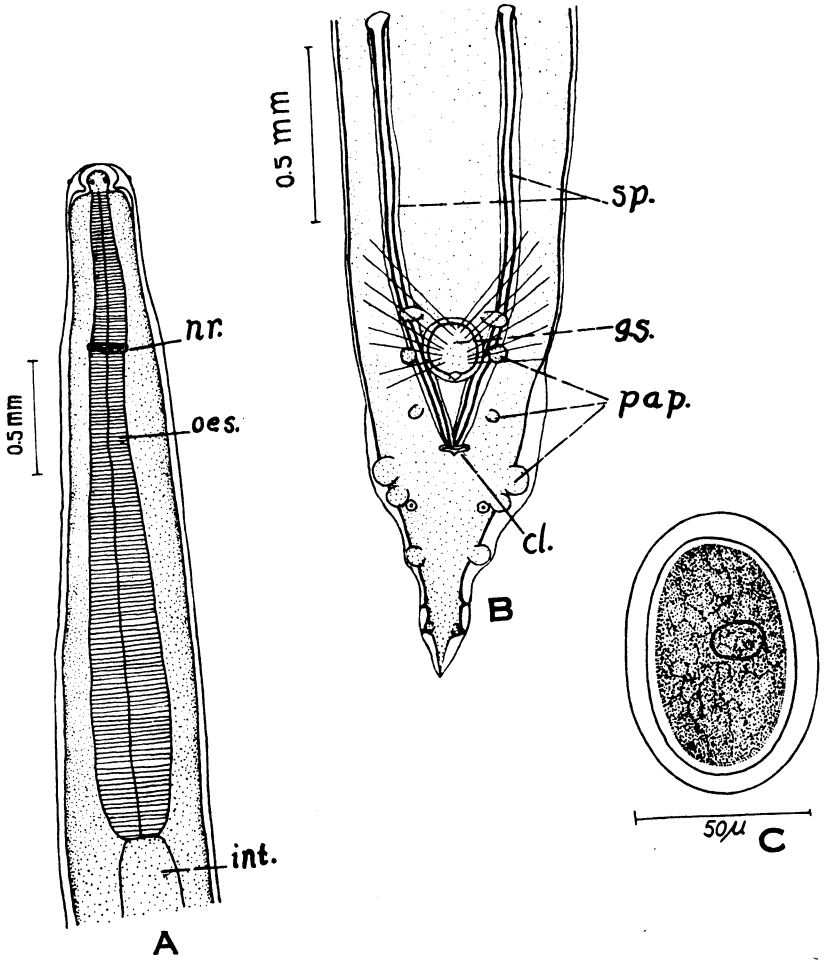

FIG. 12. *Ascaridia lineata*. A, dorsal view of anterior end of body; B, ventral view of posterior end of male; C, egg; an., anus; g.s., genital sucker; int., intestine; nr., new ring; oes., œssophagus; pap., genital papillæ; sp., spicules.

millimeters, in adult forms. Spicules terminate in prominent rounded tips. Sucker, circular, 0.20 to 0.25 millimeter in diameter in adult forms and smaller in young specimens. Tail, 0.5 to 0.7 millimeter long, with slender tip in adult forms and provided with weakly-developed alæ.

Female.—Vulva, approximately at middle of body. Anus, 1.1 to 1.3 millimeters from tip of tail in adult forms. Eggs, elliptical, with smooth thick shell, 0.080 by 0.050 millimeter in size

Location.—Small intestine; occasionally gizzard and proventriculus.

Life history.—Direct. According to Ackert (1920, 1923), who probably studied the life history of *Ascaridia lineata* instead of *A. perspicillum*, as the paper by Schwartz (1925) seems to suggest, the larvæ seldom go to the liver, lungs and other organs, as is the case with *Ascaris lumbricoides* and other closely related worms.

Ascaridia Compar (Schrank, 1790). Fig. 13.

SYNONYM.—*Heterakis compar* (Schrank, 1790).
REFERENCES.—Baylis and Daubney (1922), Mueller (1897), Neveu-Lemaire (1912).

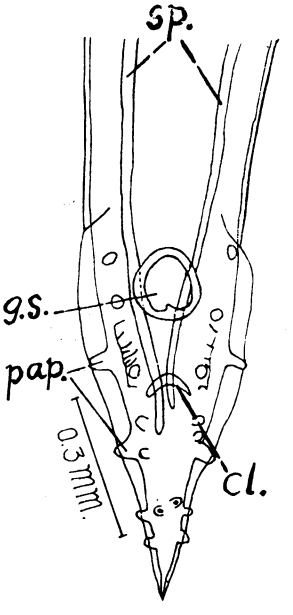

FIG. 13. *Ascaridia compar:* ventral view of posterior end of male (after Baylis and Daubney, 1922). an., anus; g.s., genital sucker; pap., genital papillæ; sp., spicules.

Specific diagnosis.—Mouth with three lips; dorsal lip larger than submedian lips; each lip provided with a central papilla.

Male.—Length, 36 to 48 millimeters. Bursa provided with 10 pairs of genital papillæ arranged in three groups as follows—an anterior group of three pairs of ventral and one pair of lateral papillæ, lateral to sucker and anterior to cloacal opening; a second group of two pairs of ventral and one pair of lateral papillæ immediately posterior of cloacal opening; a third group of 1 pair of ventral and two pairs of lateral papillæ in the region of tip of tail. Spicules, equal. Sucker, oval, 0.34 by 0.30 millimeter in size.

Location.—Small intestine and "stomach."

Life history.—Not worked out, but presumably similar to that of Ascaridia lineata.

This species is not represented in the collection at my disposal. It is mentioned here, for it is referred to by Neveu-Lemaire (1912) as having been reported by Chierchia (date not given) from the "stomach" of chicken in the Philippines.

Superfamily *Spiruroidea* Railliet and Henry, 1915.
Family *Acuariidae* Seurat, 1913.
Subfamily *Acuarinae* Railliet, Henry and Sissoff, 1912.

Genus **CHEILOSPIRURA** Diesing, 1861

Cheilospirura hamulosa (Diesing, 1851). Figs. 14, 15.

SYNONYM.—*Dispharagus hamulosus* (Diesing, 1851).
REFERENCE.—Neveu-Lemaire (1912).

The following description is based entirely on Philippine material.

Specific diagnosis.—Body with 4 double cuticular bands extending from cephalic end to, sometimes beyond, posterior sixth of body. Up to level of nerve ring, bands are wavy in appearance; beyond that level they have the appearance of segmented cords. Mouth with two conical lips, each lip with two papillæ. Oesophagus, approximately one-third of body length, 0.15 millimeter in maximum width, and consisting of three por-

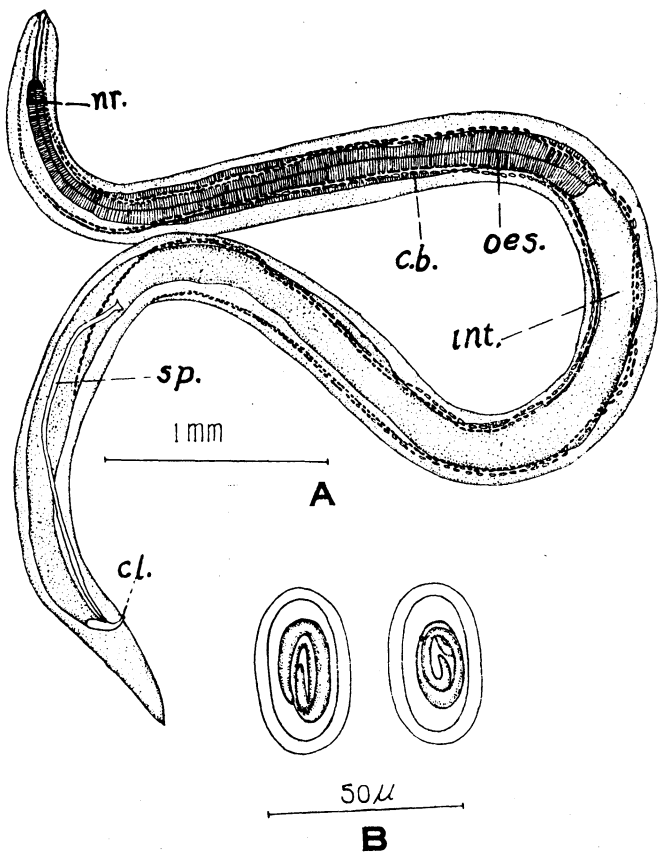

FIG. 14. *Cheilospirura hamulosa*. A, side view of entire worm; B, eggs. c.b., cuticular bands; cl., cloacal opening; int., intestine; nr., nerve ring; oes., œsophagus; sp., spicule.

tions—an anterior portion, thin-walled, about one-twelfth; a middle muscular portion, about two-twelfths; and a posterior muscular portion, nine-twelfths, of total length of œsophagus. Nerve ring, 0.28 millimeter from cephalic end.

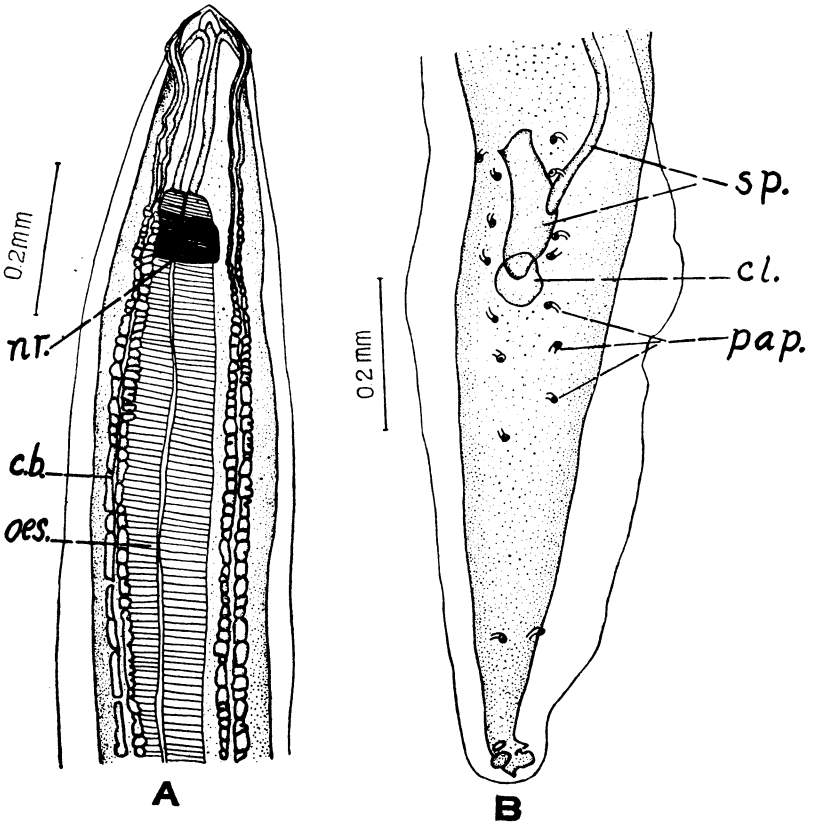

FIG. 15. *Cheilospirura hamulosa*. A, lateral view of anterior end of body; B, ventral view of posterior end of male. c.b., cuticular band; cl., cloacal opening; nr., nerve ring; oes., œsophagus; pap., genital papillæ; sp., spicules.

Male.—8.5 to 12 millimeters in length by 0.3 millimeter in maximum width. Caudal alæ, weakly-developed. At least ten pairs of stalked genital papillæ, ventral in position, four pairs being preanal, and six pairs postanal. Last two pairs of postanal papillæ near tip of tail, larger than other papillæ. Spicules, dissimilar—right spicule, shorter but broader, 0.5 by 0.06 millimeter in size; left spicule, longer but narrower, 1.82 millimeters by 0.013 millimeter in dimensions. Cloacal opening, 0.6 to 0.7 millimeter from tip of tail.

Female.—21.5 to 23.5 millimeters in length by 0.5 millimeter in maximum width. Anus, 0.5 to 0.6 millimeter from posterior end. Vulva, behind equator of body, about 10.5 millimeters from posterior end. Mature eggs, with smooth thick shell, 0.043 to 0.045 by 0.024 to 0.025 millimeter in size.

Location.—In musculature of gizzard.

Life history.—Unknown.

Genus **Dispharynx** (Railliet, Henry and Sissoff, 1912)

Dispharynx spiralis (Molin, 1858). Fig. 16.

SYNONYMS.—*Dispharagus spiralis* Molin, 1858.
Acuaria spiralis Railliet, Henry and Sissoff, 1912.

REFERENCE.—Seurat (1916).

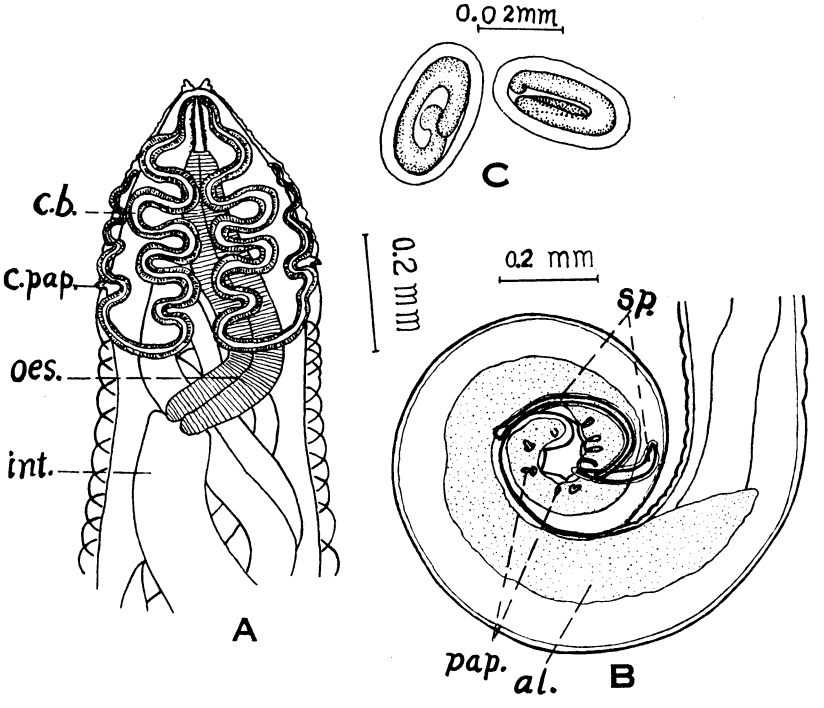

FIG. 16. *Dispharynx spiralis.* A, ventral view of anterior end of body; B, lateral view of posterior end of male; C, eggs. al., caudal wing; c.b., cuticular band; c.pap., cervical papilla; int., intestine; oes., œsophagus; pap., genital papillæ; sp., spicules.

Specific diagnosis.—Anterior portion of body provided with 4 double cuticular bands, extending in zigzag manner from immediately behind mouth to as far as, or anterior of, level of posterior limit of œsophagus; from that level they bend back

anteriorly. Two cervical papillæ situated at different levels, 0.28 to 0.83 millimeter; nerve ring, 0.2 to 0.4 millimeter; excretory pore, 0.32 to 0.45 millimeter, from cephalic end. Mouth with two lips, each lip provided with a conical tooth and a pair of papillæ. Œsophagus consists of two portions—a short, thin-walled anterior portion, 0.09 to 0.12 millimeter long and a muscular glandular posterior portion, 0.58 to 0.93 millimeter long.

Male.—4.5 to 8.3 millimeters long by 0.3 to 0.5 millimeter wide. Posterior extremity bent spirally. Caudal alæ, elongated, supported by four pairs of preanal papillæ and five pairs of postanal papillæ. Spicules, dissimilar—right spicule, boat-shaped, short but wider, 0.15 to 0.20 millimeter long; left spicule, filiform, 0.45 to 0.52 millimeter long. Cloacal opening, 0.31 to 0.34 millimeter from caudal end.

Female.—5.5 to 10.2 millimeters long by 0.50 to 0.56 millimeter wide. Tail, short, conical, bearing ventrally near tip a small unpaired papilla. Vulva, anterior to equator of body. Anus, 0.11 to 0.13 millimeter from tip of tail. Mature eggs, with smooth shell, containing vermiform embryo, 0.033 to 0.035 by 0.018 to 0.025 millimeter in size.

Location.—Proventriculus.

Life history.—Unknown.

Family *Spiruridæ* Oerley, 1885.
Subfamily *Gongylonemin*æ Hall, 1916.

Genus **GONGYLONEMA** Molin, 1857

Gongylonema ingluvicola Ransom, 1904. Fig. 17.

REFERENCES.—Ransom (1904 b), Wharton (1918 b).

Specific diagnosis.—Anterior end of body with a zone of shields or cuticular bosses, extending backward and arranged more or less regularly in longitudinal rows, about 16 rows in entire circumference of body in male and 20 to 24 rows in female. Excretory pore, 0.300 to 0.480 millimeter; cervical papillæ, 0.100 to 0.150 millimeter; nerve ring, 0.215 to 0.325 millimeter, from anterior end. Narrow, inconspicuous lateral membranes present on each side of body, extending from a short distance behind cervical papillæ to a distance of 0.200 to 0.600 millimeter from point of origin. Mouth, small; pharynx, cylindrical, 0.032 to 0.040 millimeter long. Œsophagus consists of two portions—a short, slender anterior portion, 0.280 to 0.608 millimeter long and a thick posterior portion, 3.2 to 6 millimeters long.

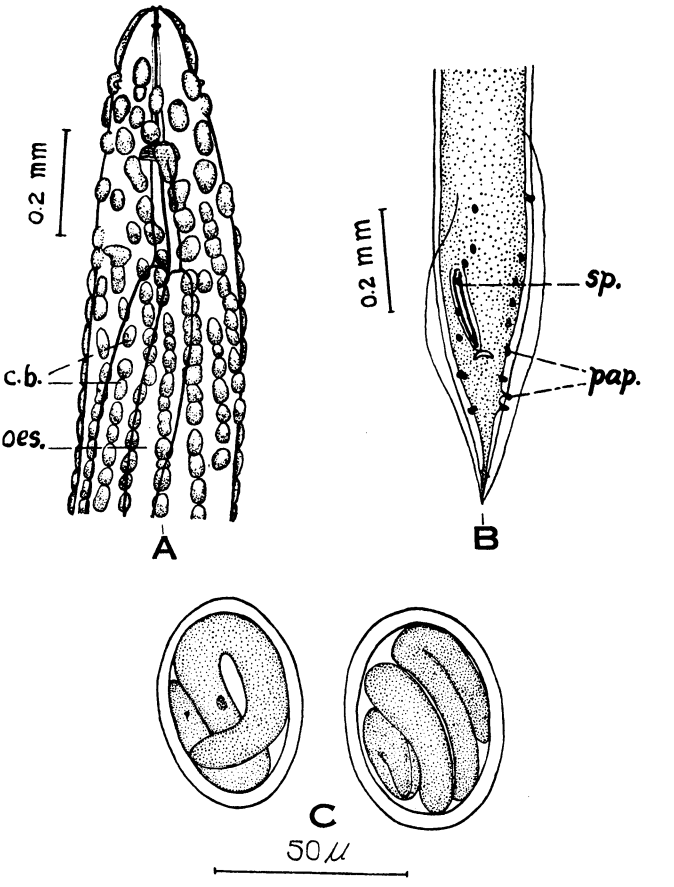

FIG. 17. *Gongylonema ingluvicola*. A, ventral view of anterior end of body; B, ventral view of posterior end of male; C, eggs. an., anus; c.b., cuticular bosses; oes., œsophagus; pap., genital papillæ; sp., spicule.

Male.—17 to 20 millimeters long by 0.224 to 0.256 millimeter in maximum width. Tail with two narrow, asymmetrical alæ. Genital papillæ variable in number, but not more than 10 pairs, and may not be symmetrically placed. Number of preanal papillæ on left side, 2 to 7; on right side, 4 to 7. Number of postanal papillæ on left side, 3 to 4; on right side, 2 to 5. Spicules, dissimilar—left spicule, filiform, with barbed point, 17 to 19 millimeters long by 0.007 to 0.009 millimeter wide; right spicule, 0.100 to 0.120 by 0.015 to 0.020 millimeter in size. Cloacal opening, 0.225 to 0.275 millimeter from tip of tail.

Female.—32 to 35 millimeters long by 0.320 to 0.490 millimeter in maximum width. Anus, 0.165 to 0.288 millimeter;

vulva, 2.5 to 3.5 millimeters, in front of tip of tail. Mature eggs, with coiled vermiform embryo, 0.050 by 0.036 millimeter in size.

Location.—In burrows in mucous lining of crop.

Life history.—Not determined. Judging, however, from the life histories of *Gongylonema* species which are parasitic in mammals and which spend their infective larval stages in certain beetles and cockroaches, it may be assumed that *Gongylonema ingluvicola* also requires an intermediate host in its development from the egg to the adult stage.

Family *Tetrameridæ* Skrjabin, 1916.
Subfamily *Tetramerinæ* Railliet, 1915.

Genus **TETRAMERES** Creplin, 1846

Tetrameres fissispina (Diesing, 1860). Fig. 18.

SYNONYMS.—*Tropidocerca fissispina* Diesing, 1860.
Tropisurus fissispinus Neumann, 1888.
REFERENCES.—Seurat (1918), Travassos (1919), Wharton (1918 a).

Specific diagnosis.—Sexual dimorphism very prominent.

Male.—Thread-like, white in color, 3.48 to 5 millimeters in length by 0.09 to 0.20 millimeter in maximum width. Along each lateral and median line is a single row of small spines pointing backward and extending from just behind buccal cavity to beyond level of cloacal opening, which is 0.13 to 0.25 millimeter from tip of tail. Cervical papillæ, 0.18 millimeter; nerve ring, 0.22 millimeter; excretory pore, 0.28 millimeter, from anterior end. Buccal cavity, short. Œsophagus composed of two portions—a slender, muscular anterior portion, 0.42 millimeter long and a wide, glandular posterior portion, 0.876 millimeter long. Spicules, dissimilar—right spicule, short, sharp-pointed, 0.115 to 0.140 millimeter long by 0.004 millimeter thick; left spicule, thick, with a rounded end, 0.310 to 0.320 millimeter by 0.015 in size.

Female.—1.67 to 6 millimeters in length by 1.08 to 3.5 millimeters in maximum width. Body subglobular, blood-red in color, with slender cephalic and caudal extremities, transversely striated, with four longitudinal depressions corresponding to median and lateral lines. Extremities more or less retractile and movable from side to side; anterior extremity at least 1.2 millimeters long and posterior extremity 0.5 to 0.9 millimeter long. Mouth with three lips, each lip bearing a terminal papilla. Œsophagus extends throughout entire length of anterior ex-

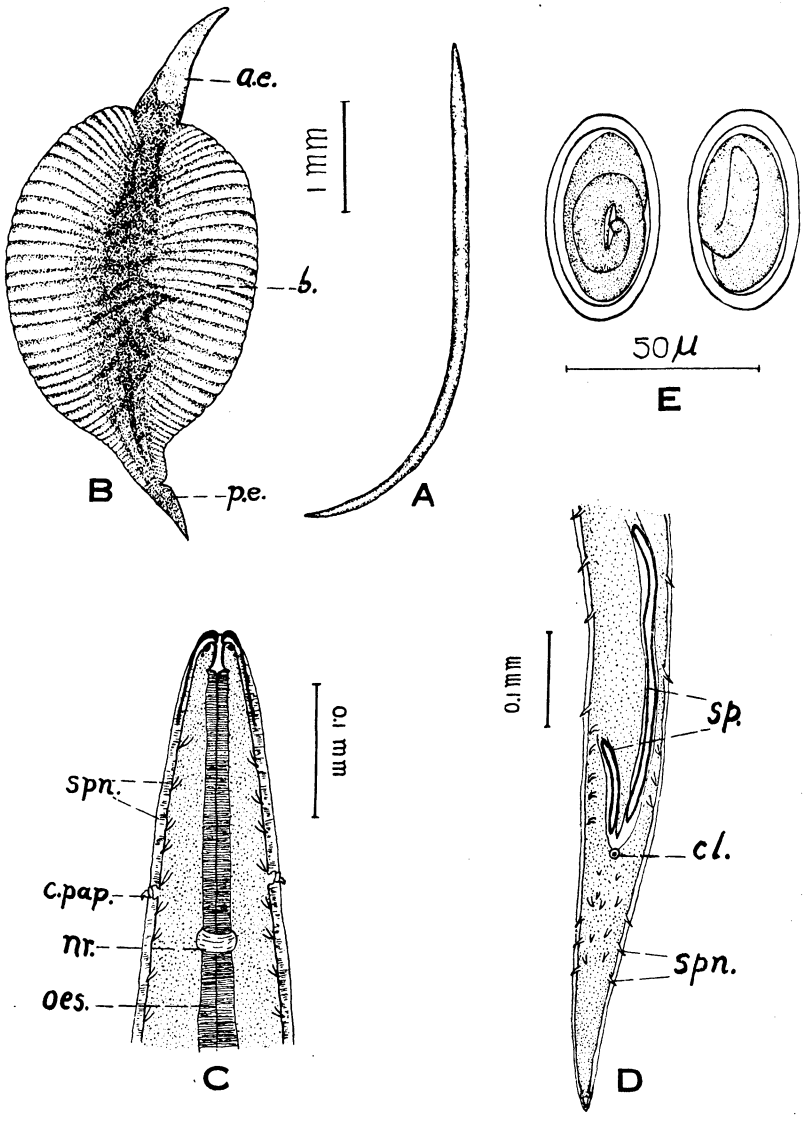

FIG. 18. *Tetrameres fissispina*. A, external appearance of entire male worm; B, external appearance of entire female worm; C, ventral view of anterior end of male; D, ventral view of posterior end of male; E. eggs. a.e., anterior extremity; b., body; cl., cloacal opening; c.pap., cervical papilla; nr., nerve ring; oes., œsophagus; p,e., posterior extremity; sp., spicules; spn., spines.

tremity. Nerve ring, 0.14 millimeter; cervical papillæ, 0.10 millimeter; excretory pore, 0.19 millimeter, from anterior end. Anus, 0.07 to 0.20 millimeter from posterior end. Vulva, at junction of posterior extremity with body. Mature eggs, oval,

with smooth thick shell, containing vermiform embryos, 0.048 to 0.056 by 0.025 to 0.030 millimeter in size.

Location.—Males lie either free in lumen of proventriculus or with one end buried in a duct of the gastric glands of the proventriculus. Females lie embedded in the gastric glands of the proventriculus.

Life history.—Unknown.

Family Thelaziidae Railliet, 1916.

Genus **OXYSPIRURA drasche** (in Stossich, 1897)

Oxyspirura mansoni (Cobbold, 1879). Fig. 19.

SYNONYM.—*Filaria mansoni* Cobbold, 1879.
REFERENCE.—Ransom (1904 a).

Specific diagnosis.—Mouth surrounded by chitinous ring which is divided into six lobes by narrow clefts. Six small papillæ project from surface of head near outer edge of chitinous ring and in relation to clefts. On sides of head posterior of circle of papillæ, are four other papillæ, the sublateral papillæ. Mouth opens into buccal cavity, which is 0.040 to 0.060 millimeter long. Œsophagus, 1.5 millimeters long by 0.080 to 0.100 millimeter in maximum width. Cervical papillæ, inconspicuous, 0.350 to 0.400 millimeter; nerve ring, about 0.250 millimeter, from anterior end. Excretory pore in ventral line at about level of cervical papillæ. A pair of small, conical papillæ situated near tip of tail in both sexes.

Male.—10 to 16 millimeters in length by 0.200 to 0.350 millimeter in maximum width. Tail curved ventrally. Six pairs of genital papillæ—2 pairs postanal and 4 pairs preanal in position. Spicules, very dissimilar, each enclosed in a close-fitting sheath,—long, slender spicule, 3 to 3.5 millimeters by 0.008 to 0.010 millimeter in size; short, boat-shaped spicule, 0.320 to 0.400 by 0.030 millimeter in size. Cloacal opening, 0.320 to 0.400 millimeter from tip of tail.

Female.—12 to 18 millimeters in length by 0.400 to 0.430 millimeter in maximum width. Double system of ovaries, oviducts and uteri. Vulva, 1 to 1.4 millimeters; anus, 0.400 to 0.530 millimeter, from tip of tail. Mature eggs, oval, with vermiform embryos, 0.050 to 0.065 by 0.040 to 0.045 millimeter in size.

Location.—Beneath nictitating membrane of eye.

Life history.—Unknown.

Superfamily *Trichinelloidea* Hall, 1916.
Family *Trichuridæ* Railliet, 1915.
Subfamily *Trichurinæ* Ransom, 1911.

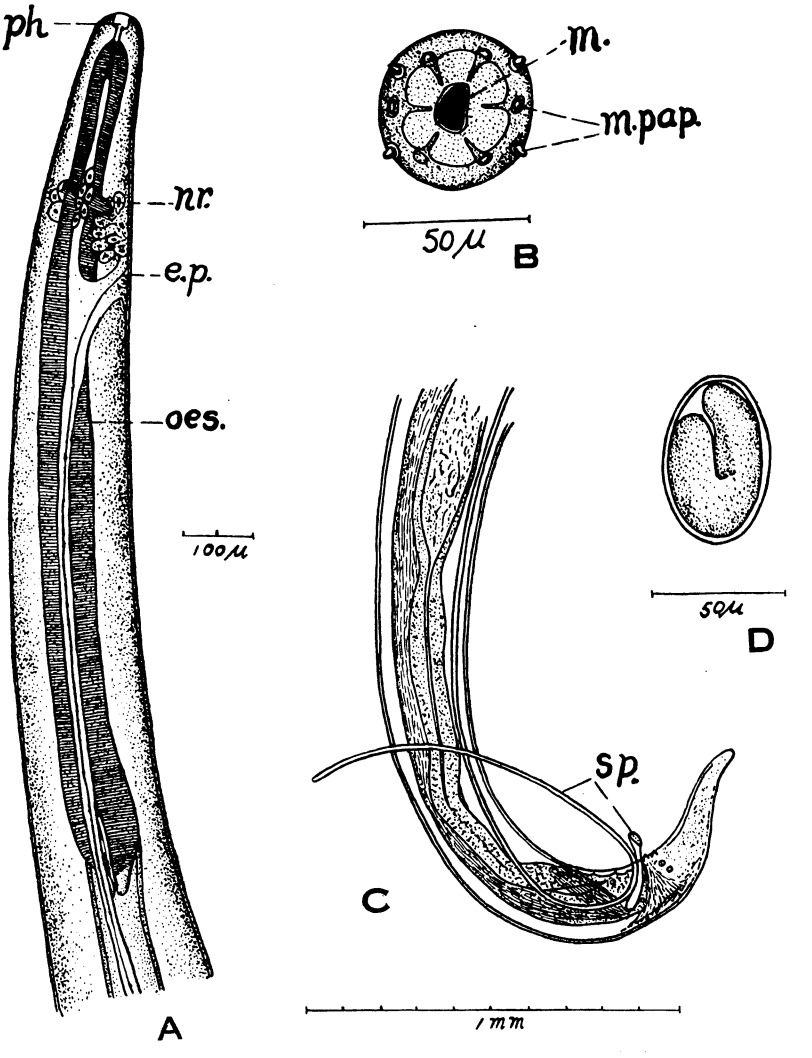

FIG. 19. *Oxyspirura mansoni*. A, side viiew of anterior end body; B, anterior view of head; C, side view of posterior end of male; D. egg. (All after Ransom, 1904 a.) e.p., excretory pore; m., mouth opening; m.pap., mouth papillæ; nr., nerve ring; oes., œsophagus; sp., spicules.

Genus **THOMINX** Dujardin, 1845

Thominx annulata (Molin, 1858). Fig. 20.

SYNONYMS.—*Trichosomum strumosum* Reibisch, 1893.
Capillaria strumosa (Reibisch, 1893).
REFERENCES.—Cram (1925), Reibisch (1893), Travassos (1915), Wharton (1918 b).

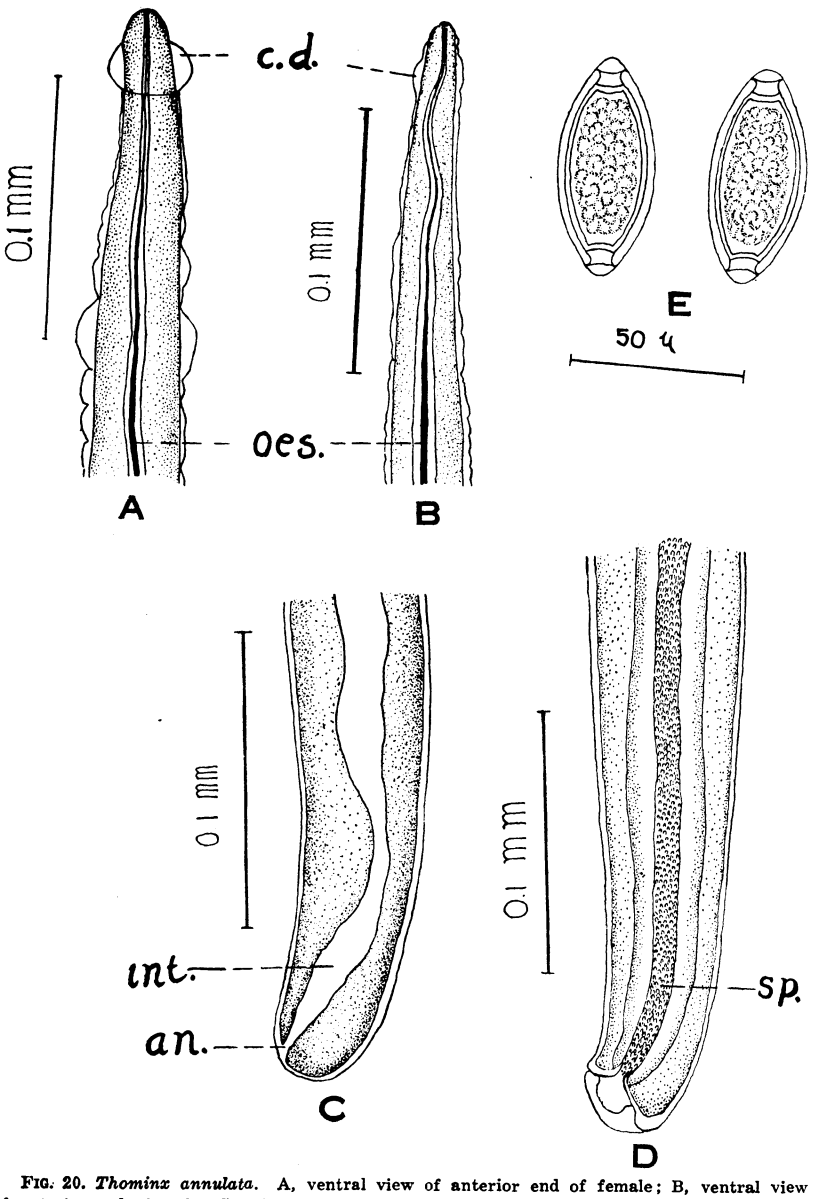

FIG. 20. *Thominx annulata*. A, ventral view of anterior end of female; B, ventral view of anterior end of male; C, side view of posterior end of female; D, side view of posterior end of male; E, eggs. an., anus; c.d., cuticular dilatation; int., intestine; oes., œsophagus; sp., spicule.

Specific diagnosis.—Anterior extremity presents a cuticular dilatation which is very pronounced in female, less so in male.

Two bacillary bands present—dorsal and ventral. Dorsal band, about two-fifths of diameter of body; ventral band, about three-fourths of body diameter. Slender anterior portion of body occupied by œsophagus and constitutes one-fourth to one-third of total body length in male and one-seventh to one-sixth in female.

Male.—17 to 25 millimeters in length by 0.070 to 0.100 millimeter in maximum width. Posterior extremity, bilobed. Cloacal opening, terminal, in depression between two lobes of posterior end. One very long spicule, enclosed in a sheath with very fine spines.

Female.—37 to 55 millimeters in length by 0.085 to 0.150 millimeter in maximum width. Vulva, not prominent, about 0.5 millimeter behind origin of intestine. Anus, terminal. Eggs, lemon-shaped, plugged at both ends, with smooth surface, 0.060 to 0.065 by 0.025 to 0.028 millimeter in size.

Location.—Under epithelium of crop.

Life history.—Not determined.

Genus **CAPILLARIA** Zeder, 1800

Capillaria retusa (Railliet, 1893). Fig. 19.

SYNONYM.—*Trichosomum retusum* Railliet, 1893.
REFERENCES.—Neveu-Lemaire (1912), Travassos (1915).

Specific diagnosis.—Slender anterior portion of body occupied by œsophagus and constitutes one-third to one-half of total length of body in male and one-half to three-fourths in female. Ventral bacillary band, about one-half of diameter of body, present.

Male.—9.5 to 13 millimeters in length by 0.039 to 0.080 millimeter in maximum width. Posterior extremity, truncated and with 2 terminal lobes, between which on ventral surface is the cloacal opening. Only one spicule—long, with smooth surface, 0.866 to 1.060 millimeters long by 0.013 to 0.014 millimeter in maximum width.

Female.—13 to 19 millimeters in length by 0.042 to 0.100 millimeter in maximum width. Vulva, moderately prominent, at, or immediately anterior of, middle of body. Anus, subterminal. Eggs, lemon-shaped, plugged at both ends, with rugose surface, 0.050 to 0.063 by 0.028 to 0.035 millimeter in size.

Location.—Lumen of cæca.

Life history.—Not determined.

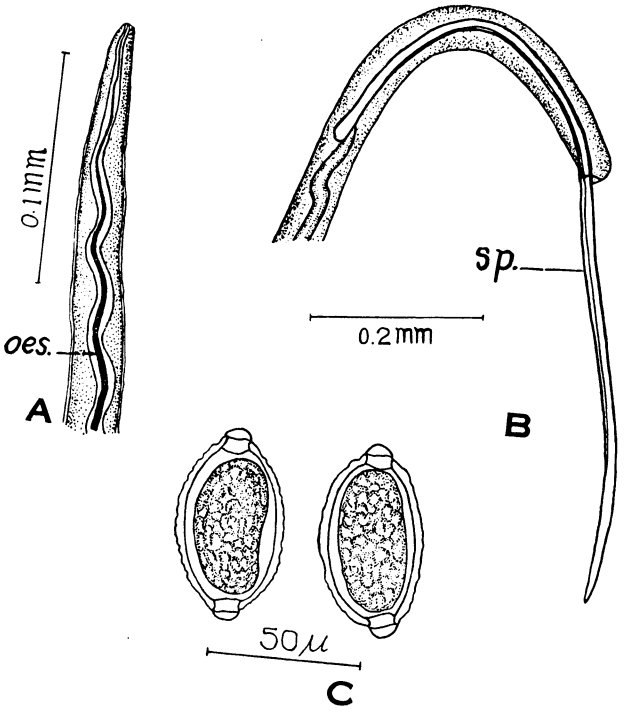

FIG. 21. *Capillaria retusa*. A, ventral view of anterior end of body; B, side view of posterior end of male; C, eggs. oes., œsophagus; sp., spicule.

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PREVENTION OF THE SPREAD OF CONTAGIOUS DISEASES AMONG ANIMALS IN THE SUGAR-CANE PLANTATIONS

By PEDRO P. VILLA, D.V.M.

The most prevalent contagious and infectious diseases of animals in this country are rinderpest, anthrax, foot-and-mouth disease and surra, and these diseases occur among animals in the sugar-cane plantations throughout the Islands as well as elsewhere. There are other contagious diseases of animals in the Philippines but these four are the most important from the economic viewpoint. So in the preparation of this paper only these four have been taken into consideration.

HYGIENE

To prevent the spread of these diseases among the animals in the cane plantations it is essential that the following measures be strickly observed i. e., practised at all times and under all conditions.

Working animals should be provided with corrals and sheds in which to find shelter when not at work, and these sheds should be constructed on high ground so that the animals will always have a dry place to lie down and sleep, as is necessary; and, if possible, provided with cement floors and with good drainage facilities so they can be easily washed and properly disinfected. And at any rate the floor should be kept clean.

The pasture of the plantations should be from time to time carefully inspected to see if there are any places from which the animals should be kept away. Every polluted, slimy, or muddy watering place should be either covered or fenced-in to prevent the animals from drinking the contaminated water. The animals must be prevented from grazing in all fields or places where the soil may be infected. The risk of pasturing animals in such fields may be eliminated, however, by constant draining and cultivation.

In places in the plantation where working animals under existing circumstances may have to remain for some time and where there is no sanitary shed to house them, temporary sheds

of light materials may be constructed for them but their manure and other waste should be shoveled up and deposited in a hole and not left to get scattered here and there. The hole should be constantly covered with dry waste feed during the time it is being filled up. This is to minimize the breeding of flies and other insects which spread diseases—surra, for instance. When the hole is full, it should be finally covered with earth.

When it is noticed that flies, cattle-ticks, and lice are becoming troublesome among the animals in the plantation, steps should be taken immediately to destroy these pests. All animals badly infested with either cattle-ticks or lice should be isolated in a shed—if possible, one with a cement floor—where they can easily be bathed with insecticide, or the parasites picked off by hand and destroyed. The veterinarian or livestock inspector of the cane plantation should watch every nook and corner where these insects like to breed and destroy the nests by burning or by covering them with a good disinfectant. The constant use of disinfectants, such as creoline in case of rinderpest infection, bichloride of mercury for anthrax, and carbolic acid for foot-and-mouth disease, is advisable.

Carabaos naturally love to wallow and should be allowed to wallow, but only in a body of water where there is a constant current so that the water is fresh all the time. Stagnant bodies of water, muddy water, and water polluted in any way is not safe for the animals to wallow in, for they will drink the infected water and even if they do not develop symptoms of some disease very shortly they will easily fall a prey to any epidemic.

FEEDING

If the working carabaos and cattle are put out to pasture the pasture should be enclosed with a good wire fence so that stray animals from outside that might bring in infection can not get in. If they are fed with green grass and hay these feeds should be obtained from non-infected districts. When there is not enough green feed produced locally during summer and if it is necessary to purchase fresh or dry feed from outside, an investigation should be made to determine whether or not the place of origin of the feed is or has been infected by a contagious disease—particularly anthrax. As has been experienced, serious outbreaks of anthrax in some towns and places have been due to the introduction of infected feed from infected districts.

Working carabaos and cattle, in fact, all animals in the plantation, ought to drink nothing but good water and *not* any polluted, muddy, or stagnant water from pools. When the animals are thirsty, especially after work or during the summer season, they will naturally drink any water within their reach when they are allowed to roam at large. This is not safe, and the chances are that an outbreak of a contagious disease may occur sooner or later as the direct result. In the sugar-cane plantations artesian wells ought be provided, not only for the use of human beings but also for domestic animals. There is no easier or commoner way of introducing anthrax or rinderpest into the body of an animal than by way of infected water as well as feed. This being a fact, it is of the last importance that the animals should have only good clean water as well as wholesome feed. If they are only provided with wholesome feed and good clean water all the time, the possibility of outbreaks of contagious diseases of animals will be far more remote.

Females and bulls intended for breeding should be allowed to graze at large, but in separate pastures. Animals that have become debilitated or exhausted due to overwork should be given a chance to recover their vitality by being allowed to rest and graze in another separate pasture, and be hand-fed once in a while in addition. Hand-feeding in their stalls is advisable for all animals that are daily engaged in work.

Work bullocks while at rest (not working) should be turned out on good pasture all the time. When working, however, they should be fed with concentrated feed besides green forage, which feeds should be given twice daily, early in the morning and at noon at least two hours before starting to work. A good concentrated feed is composed of the following mixtures:

50 per cent first-class tiquitiqui 30 per cent ground corn	80 per cent ground corn.
20 per cent copra meal	20 per cent copra meal.

The bullocks should be allowed as much green feed as they desire to eat.

The green feed should, if possible, be of two kinds: grasses as bungalon, Napier, Para, Guinea, Bermuda, Uba cane, ordinary zacate, and leguminous feeds like manimanian, mani, utao, soy beans, cowpeas, mungo, and cadios—all of which have been tried and found to grow well in these Islands.

Concentrated feed should be given at least 2 kilos twice a day per animal of 400 kilos.

To be healthy an animal must always have enough good food to eat and clean water to drink.

DISPOSITION OF DEAD ANIMALS

In case of anthrax, the carcass should be cremated, if possible, in order not to give the vegetative organisms a chance to develop spores, which are most dangerous in disseminating infection. Should cremation be impossible, the carcass—if buried—should be covered first with plenty of quick-lime and the hole then filled with earth. The grave should be well fenced and marked as an anthrax grave. If all positive cases of anthrax could be well located and the carcasses wherever found always thoroughly cremated there would be no need of strict quarantine regulations as for rinderpest. The most practical and effective measure for preventing the spread of anthrax is to have a positive diagnosis of the disease and the animals that have died of the disease. When the vegetative anthrax organisms are not given a chance to develop spores the disease, even if not entirely eradicated, can be easily and quickly got under control.

If it can be done, the bodies of animals that have died of rinderpest should be disposed of in the same way as in anthrax cases except, however, that there is no need of fencing and identifying the graves. Rinderpest has no power to form or develop spores and once buried the virus is destroyed.

ISOLATION CORRALS

All hospital corrals should be constructed in isolated places. They should have two fences, the inner one at least 10 meters square and the outer one 5 meters distant from the inner fence. The fences should be so constructed as to be proof against all small animals. A hole 2 meters deep should be excavated in one corner of the inner corral for the disposal of all excreta; three meters from the inner fence and encircling the corral, a trench about 6 decimeters deep should be excavated. The trench is for the purpose of catching all drainage from the corral in time of rain, and some disinfectant should be poured into it. An artificial shade should be provided over the corral. The infected animals should be confined in the inner corral.

MANAGEMENT OF CORRALS

There should be a caretaker to care for the sick animals in the isolation corral, which should always be kept clean. The caretaker before leaving the corral should thoroughly dis-

infect his feet and hands. Ropes and baskets should not be taken away from the corrals but should be burned after being used there. Iron pails and cans may be removed but should be first disinfected. No other person should be allowed to enter the corrals except the caretaker.

CORRALS FOR INDIVIDUAL ANIMALS

Should an infection occur in a plantation, all healthy animals therein should be provided with individual corrals. These should be about 2½ meters square and fenced. A bamboo screen will answer this purpose. All those animals that are suspects or already infected and which happen to be in a place far away from the big isolation corral when they catch infection, so that their transfer to the main corral appears to be impracticable, should be enclosed by a good individual corral so made that small animals can not get in. The animals must be fed and watered inside of these corrals.

IMMUNIZATION AND VACCINATION

Another preventive measure against rinderpest is the vaccination of all carabaos and cattle in the sugar-cane plantation with rinderpest vaccine. This vaccine is manufactured by the Bureau of Agriculture. Although its preparation was begun ten years ago, it is only of late that it has been extensively used to control heavy outbreaks of rinderpest in the provinces. During the last few years the Provinces of Iloilo, Capiz, Bulacan, Batangas, Pampanga, and Nueva Ecija were at various times seriously infected with this disease, the working carabaos and cattle dying by thousands. In addition to our regular quarantine restrictions, vaccination was done in badly infected towns of these provinces and undoubtedly these two things, quarantine and vaccination combined, produced very good results. We were able to control the spread of the disease within reasonable time.

It was some time ago that the law making rinderpest vaccination compulsory was passed by the Legislature. Following our plan to check the disease by both quarantine and vaccination, the same procedure but on a bigger scale, was followed in Pangasinan, which province was very badly infected. If a sugar-cane plantation is badly infected at the outset, it is advisable to give serum inoculation in the center of the infection and vaccine to the rest of the healthy animals in the plantation. Serum produces immediate protection although for

a shorter time. Good anti-rinderpest serum protects the animal against rinderpest for at least 12 days, and this gives enough time to protect the whole herd from generalized infection by enforcing quarantine restrictions, sanitary measures, proper feeding and watering, and vaccination. Rinderpest vaccination produces an immunity for at least a year. The immunity may last two years or more; it depends upon the age and idiosyncrasy of the individual animal. It is safe, however, to say that the average duration of the immunity produced by rinderpest vaccine is one to two years and consequently it is advisable to vaccinate all carabaos and cattle in the sugar-cane plantations once every year.

SIMULTANEOUS METHOD

There is another way of immunizing carabaos and cattle against rinderpest, i. e., the simultaneous method, that is, the use of both serum and virulent blood. It produce a longer period of immunity—perhaps life protection. We are doing this kind of immunization right along with the carabaos from French Indo-China and the result obtained in our laboratory is almost one hundred per cent. But in view of the fact that the virulent blood to be used with this method may transmit disease other than rinderpest to healthy animals, its application is only advisable in already infected territories and then only when it is certain that the blood is free from protozoa and other bacteria except only those in the virus of rinderpest.

ANTHRAX

Should anthrax make its appearance in a sugar-cane plantation, it is advisable that all carabaos and cattle therein should be inoculated and vaccinated simultaneously with anti-anthrax serum and spore vaccine. Right in the center of the infection when the animals are exposed to imminent danger, serum alone should be given, as this produces an immediate protection against the disease for at least 12 days. The rest of the carabaos and cattle in the plantation must be immunized simultaneously with anti-anthrax serum and vaccine.

Two years ago, the central provinces of Luzon were badly infected with anthrax, where carabaos and cattle died by thousands from the disease. The Bureau of Agriculture in its campaign to check the disease put in force strict quarantine measure and vaccinated. In view of the fact that the Bureau has no

adequate laboratory to manufacture its serum and vaccine against anthrax, it imports these biological products from various laboratories in the United States. We have been immunizing carabaos and cattle right along in the infected towns and barrios and the result is very favorable in the control of this disease. The use of anti-anthrax serum alone combined with good hygienic conditions is very effective in controlling anthrax infection.

ROOT-AND-MOUTH DISEASE

This disease is characterized by vesicular ulcerations of the mucous membranes of the mouth and the skin at interdigital spaces.

The economic importance of foot-and-mouth disease lies in the severe losses which the owners sustain from the long period of inactivity of the affected animals, diminished milk production of dairy animals, loss of calves and sometimes even the loss of mature animals. The disease in its nature is a mild affection, death occurring only very rarely under normal conditions.

Only the contents of the vesicles are very contagious. The saliva becomes contaminated by the contents of the vesicles of the mouth and so it is a source of infection. The vesicles that develop on the feet contaminate the food, the drinking water, the stable floor, the pasture, and the highways. This is how the infection finds its way into the mouth and stomach and causes the spread of the disease.

Prevention.—All healthy animals should be protected from coming in contact with sick ones or with those which have just recovered and also from coming in contact with contaminated utensils. All susceptible animals in the plantation should be placed in quarantine. Quarantine measures as previously described for rinderpest and anthrax should be put in force for this disease. All newly introduced animals should be quarantined for at least two weeks' duration.

Proper disinfection is of great importance in the control of this disease, and this should be done immediately after the appearance of the first cases. All parts of the infected stables and premises must be disinfected with 1 per cent carbolic acid and when the disease subsides the wood-work should be painted with tar or with fresh milk of lime. The feet and udder of the affected animals should be washed twice daily with disinfectant to destroy the infectious contents of the vesicles that are developing and ulcerating.

Immunization of animals against this disease has so far produced only partially satisfactory results and the problem of general immunization has not yet been solved.

SURRA

Another disease which is also producing a considerable economic loss to the owners of the animals is surra. To carabaos and cattle it is not fatal. In fact, they are only slightly susceptible to the disease and usually become affected only mildly. Nevertheless they may harbor parasites in their blood for years. Sometimes, however, the disease causes anæmia and emaciation which may develop in a high degree and ultimately kill the carabao or cattle. In most cases, however, ultimate recovery takes place. In horses the disease is nearly always fatal. Very few affected horses recover.

Prevention.—The disease is transmitted from an infected animal to a healthy one by the bites of horse flies. If an outbreak of this disease appears in a sugar-cane plantation, it is advisable to select and separate all infected animals with the aid of blood examination, and either destroy or isolate the infected ones in a stable enclosed with wire screens into which flies cannot gain entrance. In this way it is possible to eradicate the disease which has been introduced in a place not very long before.

Horses' tails should be left their natural length as with long tails they can protect themselves to a certain extent from surra-carrying flies and other insects.

In closing this paper, I would say that hygienic conditions, proper feeding and watering of animals, not overworking, quarantine restrictions, immunization, and the services of experienced veterinarians are perhaps all to be recommended as means to prevent the spread of contagious diseases among the animals of a sugar-cane plantation.

AN ORDER REGULATING THE HANDLING OF DANGEROUS AND COMMUNICABLE ANIMAL DISEASES

[Bureau of Agriculture Administrative Order No. 55]

Pursuant to the provisions of section 1765 (*g*) of Act No. 2711 (Administrative Code of 1917), the following regulations are hereby promulgated to prescribe the method of quarantining animals sick of or that have been exposed to, dangerous and communicable animal diseases; and to regulate the interprovincial movement of animals:

SECTION 1. *Definitions.*—For the purposes of this Order the terms herein used are defined as follows:

"Domestic animals" shall apply to and include all kinds of live stock such as horses, mules, asses, cattle, carabaos, hogs, sheep, goats, dogs, deer, and circus animals or those intended to be used for show purposes.

"Large cattle" shall apply to and include horses, mules, asses, cattle, carabaos, and other domesticated members of the bovine family.

"Dangerous and communicable animal diseases" shall apply to and include all the animal diseases of a communicable character such as glanders or farcy, surra, rinderpest, pleuropneumonia, lymphangitis, foot-and-mouth disease, anthrax, hemorrhagic septicemia, hog cholera, and hydrophobia.

"Municipality" shall refer to and include all municipalities proper, chartered cities, townships, and municipal districts; and the term "municipal president" shall refer to the president of the municipality proper, or chief executive of the chartered city, township, or municipal district.

SEC. 2. *Reporting and investigation of diseases.*—The owner, manager, agent, or man in charge shall at once give notice to the lieutenant of the barrio of all cases of disease or death of large cattle not already discovered by a veterinarian. Said lieutenant shall at once inform the municipal president, who shall cause the nearest veterinarian to be notified, in order that said veterinarian may make a careful investigation. If there should be no veterinarian available, the president or a competent person designated by him, shall make the necessary investigation. If this discloses the fact that the animal is or

had been suffering from rinderpest or any other of the aforementioned diseases, said president shall at once give orders:

(*a*) For quarantining.

(*b*) For the construction of isolation corral.

(*c*) For the cleaning and disinfection of the place where the animal is or had been kept, himself or the person designated by him seeing to the burning of all garbage and other waste.

(*d*) The burning or burial of the carcass of any animal that died of any one of the diseases mentioned in the previous list.

All persons who may have been in contact with diseased animals, shall be required to disinfect their bodies and clothes, wholly or partly as the veterinarian of the Bureau of Agriculture or the municipal president may direct, and the president shall render a report to the provincial governor and to the Director of Agriculture or representative of same on any investigation made, and the action taken by him with respect to subsections (*a*), (*b*), and (*c*), and (*d*) of this section.

SEC. 3. *Weekly reports.*—The president of each municipality shall keep a complete record of all the cases of diseases or of deaths among domestic animals, and a copy of this record shall be furnished to the provincial governor at the end of each week, and he in turn shall transmit same to the veterinarian in charge of the province or in his absence to the Director of Agriculture direct.

The following data shall be given:

1. Names of barrios where cases or deaths occurred.
2. Number of cases and deaths in each barrio.
3. Number of animals of each species exposed thereto; also the total number of each species in the barrio.
4. Behavior of the sick animals.
5. Condition of animals—thin, fairly well fed or well fed.
6. Conspicuous symptoms of the disease, such as fever, loss of apetite, feces normal or thin with bloody streaks or mucus, redness of the eyes, discharge from the nose or eyes, swelling or discoloration in any part of the body.
7. Average number of days that animals were sick before death occurs.
8. Marks and other identification signs.
9. Names and residence of the owners.
10. Whether the sick animals are being or had been kept in an isolation corral constructed by the municipality, or in individual corrals constructed by the owners of the animals.

SEC. 4. *Care and movement of sick animals.*—Sick animals shall be well guarded until the completion of the quarantine

corral. They shall not be taken any considerable distance to a corral, but other corrals shall be constructed in those parts of the barrio, if necessary, where cases were found. Before any attempt is made to remove sick animals from the place where found to a quarantine corral, they shall be thoroughly disinfected—especially their feet. Any excreta dropped by sick animals on their way to a quarantine corral, same shall be saturated with disinfectant and buried.

SEC. 5. *Method of handling suspects.*—All animals susceptible to the particular disease against which quarantine has been declared that have been in contact with infected animals shall be isolated as suspects and all small animals that have been in contact with infected animals confined. Suspicious cases shall be isolated near where found until the diagnosis has been confirmed. Persons judged competent to make a diagnosis and send animals to the corral shall be designated by the veterinarian in charge of the work, or by the provincial governor after consultation with the veterinarian.

SEC. 6. *Disposition of dead bodies.*—Owners of animals which have died from infectious disease shall, where practicable, cause their bodies to be burned and shall inter any unconsumed portions remaining. Where it is impracticable to burn such bodies, they shall cause them to be interred beneath at least 1 meter of the earth. The persons burying the carcass, as well as the tools used in the work, shall be properly disinfected and lime spread over the grave to prevent dogs from digging up the carcass. In case lime is not available, brush and stones shall be piled over the grave. Live-stock inspectors, soldiers, or policemen detailed on quarantine duty shall go with the owner of a dead animal, when notified to see that the disposition of the carcass is made in accordance with this section.

It shall be unlawful to remove the skin, horns, or any other part of the body of the animal; except the bile or blood serum for use in immunizing other animals against the disease, which dies of an infectious disease, and the removal of such excepted materials shall be effected only by a veterinarian duly authorized by the Director of Agriculture.

It shall likewise be unlawful for any person knowingly to have in his possession, or knowingly to sell, offer for sale, or export the skin, horns, or any other part of an animal which has died of an infectious disease, except the bile or blood serum; and all persons having in their possessions skins, horns, or other portions of such animal shall destroy them by burning or shall

inter them. Officers of the law are hereby authorized to seize and destroy such skins, horns, or other portions of the body of any animal, wherever found, which has died of an infectious disease.

SEC. 7. *Isolation corrals.*—The municipal president shall have public corrals made twenty-four hours after any dangerous and communicable disease has made its appearance in any barrio. All quarantine corrals shall be constructed in isolated places and, when possible, at least 100 meters distant from all roads, trails, rivers, esteros, or other water courses. These corrals shall have two fences, the inner one at least 10 meters square, and the outer one 5 meters distant from the inner fence; the fences shall be so constructed as to be proof against all small animals. ("Madre de cacao" and bamboo are suitable materials). A hole 2 meters deep shall be excavated in one corner of the inner corral, 3 meters from the inner fence, for the disposal of all excreta and a trench not less than 6 decimeters deep shall be excavated to encircle the corral to catch all drainage from the corral when it rains. The trench shall be disinfected with disinfectant daily. Artificial shade shall be provided in the corral. *All the infected animals shall be confined in the inner corral.* All the animals that any veterinarian of the Bureau of Agriculture, or agent authorized by the provincial governor, may find suffering from any dangerous and communicable disease shall be confined in the corrals thus made, and not allowed to go out except upon certificate of a veterinarian stating that they are free from disease or when they are to be slaughtered as hereinafter provided.

SEC. 8. *Management of corrals.*—A competent caretaker for the corral shall be provided by the municipality, he to be directly under the orders of the municipal president. This caretaker shall care for the sick animals and keep the corral scrupulously clean. On leaving the corral, he shall thoroughly disinfect his feet and hands. He shall provide himself with a change of clothes to be used in the corral. The owner shall bring food and water for his animals, but must deposit it 10 meters from the corral, where the caretaker will receive it. No ropes or baskets are to be taken away from the corral, but shall be burned. Iron pails and cans may be removed but shall first be disinfected. The space between the two fences shall be used for the burial of the animals dying in the corral. Anyone entering an isolation corral shall disinfect his hands and feet on leaving. Cases of rinderpest shall be held in the corral

fifteen days after apparent discovery. A night and day guard shall be kept at the corral to enforce these regulations.

SEC. 9. *Quarantine of barrios and tying of animals.*—Upon the appearance of a dangerous and communicable animal disease in a barrio, said barrio shall be placed by the municipal president in quarantine. All animals of the species affected must be kept tied up 15 meters apart through the quarantine period, excepting as hereinafter provided for agricultural operations. Whenever possible individual sheds shall be constructed 15 meters apart in the fields at least 100 meters from the houses of the barrio and the animals moved into these corrals. A mother and calf may be confined in the same shed. The places where animals are kept tied up shall be kept in a sanitary condition; all excreta shall be buried in holes dug for the purpose in the immediate vicinity of where the animals are tied. If a case occurs near the boundary line of an adjoining barrio, the portion of this barrio within a radius of a kilometer from the infected barrio shall be included in the quarantined zone. In special instances this radius may be reduced to 500 meters. The written authorization of the veterinarian of the Bureau of Agriculture should, however, be obtained for this reduction. In every large barrios portions thereof may be conditionally released before the termination of the quarantine period by the same authorization. Any animals that shall have left an infected barrio within two days of the appearance of the first case shall be considered as having been exposed to the disease and shall be placed in quarantine wherever found. If they belong to the infected barrio and in the opinion of the veterinarian of the Bureau of Agriculture can be moved with safety they shall be returned to said barrio.

Small animals such as sheep, goats, dogs, deer, hogs, etc., shall be restricted from running at large, either by tying or placing in fences. Fowls within a radius of 200 meters of the places where sick animals have been found shall be confined in coops. Any small animals or fowls approaching an isolation corral within a distance of 100 meters from the outer fence of such corral shall be killed, by shooting, or otherwise destroyed.

SEC. 10. *Use of animals in quarantine areas—Passes.*—On isolated haciendas in infected barrios, or in fields where the animals may be readily inspected, the use of animals may be permitted where strictly necessary for agricultural labor, provided such use of animals could not result in the dissemination of disease. Such permission shall be granted by the provincial

governor or his authorized agent only as a pass, after obtaining the written opinion of the veterinarian of the Bureau of Agriculture. No pass shall be issued for any definite period and may be revoked at will in case such necessity arises. Ordinarily, permits shall not be issued until fifteen days have elapsed from the discovery of the first case. Whenever possible individual sheds shall be constructed 15 meters apart in or as close as practicable to the fields to be worked; each animal shall be tied in its shed when not at work, and be fed and watered there. In cases of extreme necessity, work passes may be issued before the expiration of the fifteen days after the first case. The animals must then be provided with muzzles when outside of the individual sheds. The following rules shall be observed in the issuance of work passes:

1. Passes shall be issued only when absolutely necessary for plowing the land or hauling in products which may be spoiling in the field. These passes shall be signed by the municipal president.

2. Work passes shall be numbered and issued in duplicate—one for the owner, and one for the president. The document of each animal for which a pass is issued, shall be collected and its number noted in the pass. A list of all animals having passes shall be furnished the Constabulary officer on quarantine duty. This list shall give the name of the owner, the sex and brands of the animal, and the name of the barrio. All animals working shall be kept within the limits of the barrio to which they belong.

3. Any owner desiring a work pass shall first construct a corral for each animal. This corral shall be on, or as near to the land to be worked as possible and if corrals are needed for more than one animal, they shall be at least 15 meters apart. Before issuing a pass, the president shall make certain that these individual corrals have been constructed.

4. Animals while not working shall be confined in these corrals. Animals while working or en route to the fields, shall not be permitted to come in contact with each other; or with other animals.

5. Calves shall be confined in the corral while the mothers are working.

6. No animal shall be bathed in a river or estero.

7. Passes shall not be given for animals which have been designated as suspects by a properly authorized agent.

8. No passes shall be issued to any owner who does not observe all the rules and regulations provided in the preceding section in regard to small animals and fowls. Any violation of the above rules regarding passes shall be considered just cause for taking up pass for a peroid of ten days.

SEC. 11. *Unlawful traffic.*—No one shall use for food, or offer for sale, the carcass or parts of the carcass of an animal which has died of a dangerous or communicable disease or of an unknown dangerous disease, or one that has died otherwise than by slaughter, nor shall any person throw away or dispose of any part of the carcass of said animal in any place, except in acordance with the provisions of section 6 of this Order.

SEC. 12. *Inspection of infected barrios.*—All animals in infected barrios shall be inspected daily. A policeman shall be designated by the municipal president to inspect all the animals in the barrio and make a complete report of all cases and death at the end of a week. This report shall be made in triplicate—one copy for the provincial governor, one copy for the veterinarian in charge and the other copy to be retained by the municipal president.

SEC. 13. *Inspection of adjoining barrios.*—The surrounding barrios shall be kept under surveillance, and systematic inspection thereof carried on. During the quarantine period in the infected barrio all animals of the species affected in the adjoining barrios shall be tied up with long ropes while pasturing and not allowed to run loose.

SEC. 14. *Notification of officials in the neighboring provinces.*—Whenever any dangerous communicable animal disease makes its appearance in any municipality, the veterinarian in charge or in his absence the municipal president shall immediately notify the governors of the adjoining provinces and the presidents of the neighboring municipalities or veterinarians in charge of the adjacent provinces in order that they may take the necessary precautions to prevent the introduction of the disease within their respective jurisdictions.

SEC. 15. *Termination of quarantine.*—The quarantine of a barrio or sitio shall be terminated thirty days after the discovery of the last case.

SEC. 16. *Interprovincial movement of animals.*—No passes shall be issued for the transfer of cattle, carabaos, and deer to the interior of an infected province, unless such animals can be conveyed to their ultimate destination by either water or rail, and

the approval of the veterinarian in charge of the infected province or of the Director of Agriculture has been secured. Immunized animals accompanied by certificates to that effect, signed by the proper officials, shall be exempt from all rinderpest quarantine restrictions and permitted to go either by water, rail, or overland through any province without being detained. Passes for the interprovincial movement of animals shall be issued only by representatives of the Director of Agriculture.

SEC. 17. *Incurable diseases.*—Whenever a veterinarian of the Bureau of Agriculture declares that an animal is affected with a communicable and incurable disease, such as surra or glanders, the municipal president shall try to obtain the consent of the owner of said animal to kill same if the veterinarian requires it, but in case the consent cannot be obtained, and the veterinarian thinks that the death of the animal is a necessary measure to prevent the spread of the disease, then the municipal president shall order said animal, to be slaughtered and the carcass burnt or buried at once as before required. If the animal is not slaughtered for any reason, as is stated, it shall be held in quarantine at the place and for the length of time the veterinarian or his representative may think proper, and the owner of the animal shall furnish suitable food and water during its confinement in the quarantine corral.

SEC. 18. *Quarantine of highways.*—In the case of barrios bordering on public highways becoming infected with a dangerous communicable animal disease, since the absolute closing of these highways to the traffic might occasion great monetary loss, stations shall be established on the highway at least half a kilometer distant from either end of the infected barrio where all animals of the species affected shall be halted, and thence taken through the barrios in trains at fixed hours under proper police guard. In passing through these barrios no stops shall be made. The animals under quarantine in said barrios shall be tied at least a 100 meters distant from either side of the highway.

SEC. 19. *Penalty.*—Any person who, without lawful authority to do so, contravenes or violates any of the provisions of this Administrative Order, or who obstructs or impedes or assists in obstructing or impeding the Director of Agriculture or his duly authorized representative or the municipal president in the execution of any of the provisions of this Order; or who forges, counterfeits, alters, defaces, or destroys any certificate, pass, tag, or any other legal paper issued by virtue of this Order shall be liable to prosecution, and upon conviction shall suffer the penalty

provided in paragraph second of section 2747 of Act No. 2711 (Administrative Code of 1917) which is a fine of not more than ₱300, or by imprisonment of not more than thirty days, or both, in the discretion of the court.

SEC. 20. *Prosecution.*—Any violation of this Administrative Order shall be immediately reported to and the violators shall be prosecuted by the president of the municipality concerned.

SEC. 21. *Final section.*—The provisions of this Administrative Order shall take effect on approval.

GENERAL SUGGESTION

There is a great difficulty in formulating a fixed set of instructions suitable to all the varied conditions that are found in different parts of the Archipelago. The Bureau of Agriculture will endeavor to furnish each infected province with an advisory veterinarian, who will advise as to any modification of rules that may be adopted to conform to local conditions. In the absence of a veterinarian, the Director of Agriculture should be consulted.

In handling any contagious disease a thorough knowledge of the various means of transmission of the disease is the most essential point, and the adoption of adequate measures to prevent the spread of the infection hinges on this knowledge Rinderpest is the most serious contagious disease affecting animals in the Philippine Islands. It is known that this disease is transmitted directly from infected animals to non-infected animals, and also through intermediate sources such as smaller animals, human beings, forage, and various utensils used around animals.

The temperature of an animal infected with rinderpest nearly always reaches its highest point before the advent of active, visible symptoms, and this is the time when the animal is most dangerous as a disseminator of the disease. The period of incubation may run from four to as high as fifteen days.

For this reason, it is essential that all animals which may have come in contact with the disease should be kept well isolated and guarded for a period of at least fifteen days.

In these Islands the greatest obstacle to the eradication of rinderpest is the fact that the country is practically entirely unfenced. Also it is not the custom to raise forage crops and stall-feed the animals as is done in America, Great Britain, and continental Europe. Animals of one or more barrios are turned out on some large uncultivated piece of land to pick up

their food and are thus allowed to mingle at will. Very few owners of live stock have individual fenced pastures. Thus it can readily be seen that one sick animal may be the cause of infecting large numbers of others.

Therefore, when an animal is found infected with rinderpest in any given locality the dissemination of the disease is not always halted by isolating only the animals belonging to the owner of the infected one. All the animals in the barrio infected and those adjoining that might by any possibility have come in contact with the infected animal, should be isolated and inspected daily for at least fifteen days before any passes to leave the district are issued.

One of the most important projects to be undertaken lies in the education of the owners of animals in regard to the maintenance of individual, fenced pastures, and the raising of forage crops, so that the animals may be properly fed when occasions arise that necessitate stabling.

S. YOUNGBERG
Director of Agriculture

Approved, July 7, 1926:
SILVERIO APOSTOL
Acting Secretary of Agriculture and Natural Resources

Concurred in:
HONORIO VENTURA
Secretary of the Interior

THE LIVESTOCK FAIR

By Victor Buencamino, D.V.M.

Though modest in its beginning, the Livestock Fair, which will be held in conjunction with the Carnival of Manila during the period from February 12 to 27, both dates inclusive, is bound to benefit the country at large. It will tend to stimulate the livestock industry of the Philippines in more ways than one help improve the different breeds.

It has been said time and again that the Philippines is eminently an agricultural country. Any effort to promote agriculture or any of its subsidiary lines deserve the support of the people as well as of the Government. It is thus that the committee in charge of the Livestock Fair of the coming Carnival bespeaks the support and coöperation of the people and the Government.

Attempts have been made in the past to hold a Livestock Fair which would show to some extent the progress we have made in the last few years in the breeding of animals, but these attempts have been mostly confined to dog and cat shows and in some cases to horse show. This time it is planned to hold it on a large scale and make it as representative as possible of the livestock industry of the Philippines.

The public, therefore, is most cordially requested to lend support to this phase of the next Carnival. Persons having animals which are possible prize-winners should not hesitate to enter them. Owners of cattle, horses, pigs, sheep, goats, dogs, and cats which, in their opinion, are above the ordinary, should immediately take steps to have them listed at the Carnival Headquarters for the Fair. It is only in this way that a real Livestock Fair can be started—and started right.

Here is also an excellent opportunity for the Bureau of Agriculture, specially the veterinary division and the animal husbandry division, to give the public a practical demonstration of its work to improve the breed of livestock in the provinces. The best stallions and high-grade cattle produced in the provinces should be sent to the Fair. There is no doubt that with keen interest and active participation in the Fair, the foundations of a real Livestock Fair, the first of its kind in the Orient, will be laid. This will at the same time enhance the prestige of the Philippines and mark us as among the most progressive peoples on earth.

AN INDEX TO THE BULLETINS, CIRCULARS AND ARTICLES ON ANIMAL DISEASES AND LIVESTOCK INDUSTRY IN GENERAL, PUBLISHED BY THE BUREAU OF AGRICULTURE

By EDUARDO R. ALVARADO

[1] Only the Administrative Orders published either in pamphlet form or in *the Philippine Agricultural Review;* those mimeographed or published in the Official Gazette are not included.

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NOTES—FOURTH QUARTER

THE NEW DIRECTOR OF AGRICULTURE

The Philippine Senate in its *sine die* session in November 9, 1926, confirmed the appointment of Dr. Stanton Youngberg as Director of Agriculture. The appointee has been in the service of the Philippine Government for almost 20 years, and is at present one of the oldest employees in the Bureau of Agriculture in point of service. He started as veterinarian, August 27, 1907; was promoted to supervising veterinarian, January 1, 1909; and to chief veterinarian, June 1, 1914. He was selected delegate to represent the Philippines in the Pan-Pacific Scientific Congress, Australia, on August, 1923. On the death of General Adriano Hernandez, then Director of Agriculture, in February 16, 1925, Doctor Youngberg was appointed Acting Director of Agriculture, and in November 10, 1925, *ad interim* Director. As head of the Bureau of Agriculture, he is chairman of the Fiber Standardization Board and a member of the Tobacco Board. Doctor Youngberg has also several times been President of the Philippine Veterinary Medical Association and a member of the Board of Veterinary Examiners, and is the author of several scientific papers published in the Philippine Agricultural Review and other journals abroad.

Dr. Stanton Youngberg is the seventh chief of the Bureau of Agriculture, his predecessors having been F. Lamson-Scribner, W. C. Welborn, G. E. Nesom, F. W. Taylor, H. T. Edwards, and Adriano Hernandez. ‡

E. R. A.

MANUFACTURE OF RINDERPEST VACCINE

The Director of Agriculture announces that for some months past Capt. R. A. Kelser, Veterinary Corps, U. S. Army, on duty with the Medical Department Research Board, and the Veterinary Research Laboratory of the Bureau of Agriculture working in coöperation, have conducted a series of experiments to determine the feasibility of shortening the period of prepara-

‡ Deceased.

tion of rinderpest vaccine, and thereby make it possible to quickly increase the output on short notice, and at the same time retain its maximum efficacy as an immunizing agent. The results of experiments up to date are very highly satisfactory and indicate that it will be possible to greatly reduce the length of time necessary for the preparation of this valuable product used in the control of rinderpest. It is also probable that it may eventually be possible to reduce the number of injections necessary.

The rinderpest vaccine, as now prepared, was developed exclusively by the veterinary research laboratory of the Bureau of Agriculture. It has passed its experimental stage as far as its efficacy is concerned and for the past three years has been used in greatly increasing quantities in the control of the rinderpest epizoötics throughout the Philippine Islands.

THE CARNIVAL LIVESTOCK SHOW

A livestock show on a bigger scale than has been attempted before in the Philippines will be held in connection with the Manila Carnival from February 12 to 27 this year. A large amount of space has been set aside for the show, buildings costing ₱5,000 have been erected, and prizes totaling ₱3,000 in cash beside blue ribbons and certificates will be awarded.

There will be both a permanent exhibit and temporary shows, with an entry list open to everything from goldfish to carabaos. The object of the show is to improve the quality of livestock in the Philippines, but it also offers an excellent chance for owners of really good animals to increase their value and to sell them. A nominal entrance fee will be charged and an excellent program will be printed.

The Bureau of Agriculture will enter many of its best animals into the competition. The Bureau's work in animal husbandry is expected to attract much attention.

The Pandacan Research Laboratory of the Bureau of Agriculture under Doctors Rodier and Topacio will exhibit in projectoscope the history of rinderpest and Boynton's Rinderpest Vaccine. There will also be specimens of diseases affecting cattle, such as intestinal parasites, foot-and-mouth and other diseases, for general information of the public.

The division of publications of the Bureau of Agriculture will also exhibit posters on cattle and poultry breeding and will distribute pamphlets on the most common dangerous com-

municable diseases of animals, on swine, horse, cattle, and poultry.

The temporary horse show will last for two days, the army taking the first, the civilians the second. The civilian show will offer prizes for saddle horses, native ponies shown on halter, particularly the racing type, native ponies shown in harness, and polo ponies. The Army is taking advantage of the opportunity to show how it has developed its horses. .

The show of pets, particularly of dogs and cats, promises to be one of the big social events of the season. Hitherto owners always have taken great interest in securing blue ribbons for their favorites.

A space 50 by 50 feet has been reserved for the judging of the entries in the temporary shows. The track field will be used in giving the horses a chance to show off.

The permanent exhibit will have a somewhat wider entry list than the temporary shows. Cattle of all kinds, horses, poultry, hogs, pets, rabbits, guinea pigs, and decorative fish will be welcomed.

Eighty dog kennels, 24 poultry pens with an outside rune, 12 hog pens, 20 box stalls for horses, and a like number for cattle and carabaos have been built at a cost of ₱5,000. All the animals will be kept under shelter, while exercise space in the open has been provided. The exhibit will occupy two buildings and 30,000 feet of space.

Entries are open for draft, dairy, and beef cattle; native all around, native saddle, harness, and grade or mestizo horses; all principal breeds of poultry such as Rhode Island Reds, Cantonese, White Leghorns, Plymouth Rocks, Orpingtons, Chinese, and native pit cocks; all standard breeds of hogs such as Berkshire, Poland China, Duroc-Jersey, and grades.

It hardly is expected that exhibitors of pets will leave them in the show grounds all the time. In the past it has been customary for the dogs and cats to be brought to the show about 4 p. m. and taken away again about 9. The roomy compartments and the opportunities for taking care of them are such, however, that they may be left there over night.

Entries for the show will be open until February 10, and the committee in charge is very anxious that everyone interested be cordially invited to exhibit. A statement of the conditions under which the show is to be held is now in preparation. The buildings are practically completed.

The committee is headed by Fred A. Leas, who is manager of the largest ranch in the Philippines, the old Wooster ranch at Bukidnon. The secretary is Dr. V. Buencamino. The Bureau of Agriculture is represented by Mr. Alfonso Tuason, Chief, Animal Husbandry Division, Dr. Vicente Feriols, Chief Veterinarian, Dr. Rodier, Dr. Topacio, Mr. Carlos X. Burgos, Animal Husbandman, Mr. Jose G. Guevara, Animal Husbandman, and Mr. Eduardo R. Alvarado of the Division of Publication. The Army is represented by Captain R. H. Kelser, and Captain Seth Dildine. The College of Veterinary Science has Gregorio San Agustin, the Dean and Dr. M. Mondeñedo, professor of animal husbandry. Other members are Dr. Frank Gearhart of the Santa Mesa Dairy Farm, Dr. Faustino Turla, and Dr. Julio Luz.

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DEMONSTRATION STATIONS

Lipa Demonstration Station, Batangas...	Q. B. AGUILERA, in Charge.
La Paz Demonstration Station, Iloilo...	POLICARPO PADLAN, in Charge.

QUARANTINE STATIONS

Iloilo Quarantine Station, Iloilo.....	Dr. SANTIAGO G. ROTEA, in Charge.
Pandacan Quarantine Station, Manila.....	Dr. G. A. TOTTMAN, in Charge.
Plant Quarantine Station, Manila.....	A. PONCE, in Charge.
Sisiman Quarantine Station, Bataan.....	Dr. MARCIANO ECHAVARRIA, in Charge.

RESEARCH LABORATORIES

Pandacan Veterinary Research Laboratory, Manila.	Dr. TEODULO TOPACIO, Acting in Charge.
Singalong Entomology Laboratory, Manila.	FAUSTINO OTANES, in Charge.